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John S. Howard
Director- FERC Hydro Compliance

Via Electronic Filing

June 28, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: Northfield Mountain Pumped Storage Project, FERC Project No. 2485-063
Turners Falls Hydroelectric Project, FERC Project No. 1889-081
Filing of ***Updated Proposed Study Plan***

Dear Secretary Bose:

On April 15, 2013, pursuant to the regulations of the Federal Energy Regulatory Commission (Commission or FERC), 18 C.F.R. § 5.11, FirstLight Hydro Generating Company (FirstLight), a subsidiary of IPR-GDF SUEZ North America, Inc., Licensee of the Turners Falls Hydroelectric Project (FERC No. 1889) and the Northfield Mountain Pumped Storage Project (FERC No. 2485), filed its Proposed Study Plan (PSP) for the relicensing of the Turners Falls Project and Northfield Mountain Project.

In addition to other components of the PSP, the filing included 36 proposed studies and 11 studies not being proposed. Pursuant to 18 C.F.R. § 5.11, FirstLight was required to hold a study plan meeting or meetings for the purpose of clarifying the PSP and any initial information gathering or study requests, and to resolve any outstanding issues with the respect to the PSP. FirstLight held a Study Plan Meeting on May 14, 2013 in which all of the proposed studies and studies not being proposed were briefly discussed. Thereafter, FirstLight held nine resource-specific study plan meetings to allow for more detailed discussions on each proposed study plan and on studies not being proposed. With respect to study plans, FirstLight and the stakeholders focused on working out details on study methodology. The nine meetings were held on May 14, 15, 21, and 22, and June 4, 5, 11, 12, and 14. In addition, FirstLight met with the Narragansett Tribe on June 6 to discuss proposed studies. All meeting dates and notices as well as PowerPoint materials for these meetings were published on FirstLight's website http://www.northfieldrelicensing.com. FERC attended these meetings in person and/or via teleconferencing as did numerous stakeholders.

FirstLight agreed at these meetings to update the PSP and file a single ***Updated PSP*** with FERC prior to the July 15, 2013[1] deadline for stakeholders to provide comment on the PSP. Given the size of the ***Updated PSP*** and short turnaround period for stakeholder review, modifications from the original PSP are shown in track-change to allow for easier review. A few studies required significant changes and thus are not shown as track-change; they include the following:

- 3.1.1- 2013 Full River Reconnaissance Study
- 3.1.2- Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability
- 3.3.11- Fish Assemblage Assessment
- 3.3.18- Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms

Note that Volume 2 of the original PSP, which included Appendices A-G, has not changed and thus is not being re-filed as part of the ***Updated PSP***. **FirstLight respectfully requests stakeholders to denote in any comment letters what version their comments are based on—the April 15, 2013 PSP filing or the June 28, 2013 *Updated PSP* filing.**

FirstLight is filing the ***Updated PSP*** with the Commission electronically. FirstLight is making the ***Updated PSP*** available for download on its website. To access the ***Updated PSP*** here, navigate to http://www.northfieldrelicensing.com, and click on the "documents" tab on the left side of the screen.

In addition, FirstLight is making available to the public the ***Updated PSP*** at the Northfield Mountain Visitor Center at 99 Millers Falls Road, Northfield, MA 01360 during regular business hours.

If you have any questions regarding this filing, please feel free to contact me.

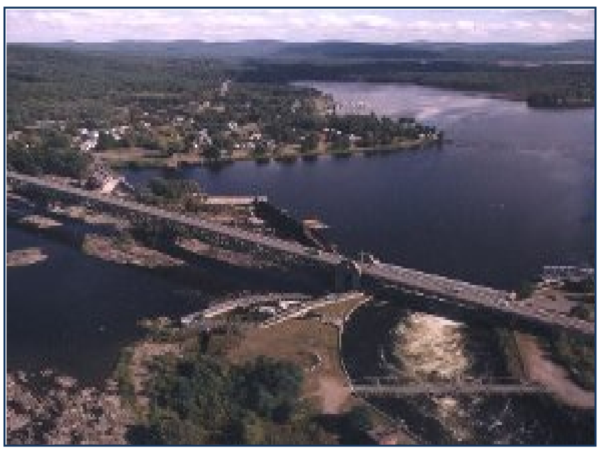
Sincerely,

John Howard
FERC- Director Hydro Compliance

[1] In Scoping Document 1 and 2, FERC provided a schedule whereby stakeholder comments on the PSP were due on July 14, 2013 which falls on a Sunday. Per FERC regulations, deadlines falling on a weekend or holiday default to the next business day—in this case July 15, 2013.

UPDATED PROPOSED STUDY PLAN

FOR THE
TURNERS FALLS HYDROELECTRIC PROJECT (NO. 1889)
AND
NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT (NO. 2485)



JUNE 28, 2013

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LIST OF ABBREVIATIONS

1-D	one dimensional
2-D	two dimensional
ADCP	Acoustic-Doppler Current Profiler
AIR	Additional Information Request
AMC	Appalachian Mountain Club
ANOVA	Analysis of Variance
APE	Area of Potential Effect
ARLAC	Ashuelot River Local Advisory Committee
ASMFC	Atlantic States Marine Fisheries Commission
AWWA	American Whitewater Association
CEII	Critical Energy Infrastructure Information
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
cfs	cubic feet per second
CPUE	Catch per Unit Effort
CRASC	Connecticut River Atlantic Salmon Commission
CRJC	Connecticut River Joint Commissions
CRSEC	Connecticut River Streambank Erosion Committee
CRWC	Connecticut River Watershed Council
CRUISE	Connecticut River Unimpacted Streamflow Estimation
CT	Connecticut
CTDEEP	Connecticut Department of Energy and Environmental Protection
CY	cubic yards
°C	degrees Celsius
°F	degrees Fahrenheit
ft	foot or feet
ft^2	square feet
DO	dissolved oxygen
DEM	Digital Elevation Model
DRTU	Deerfield River Chapter of Trout Unlimited
DVR	Digital Video Recorder
EA	Environmental Assessment
ECP	Erosion Control Plan
ESA	Endangered Species Act

FERC or Commission	Federal Energy Regulatory Commission
FIS	Flood Insurance Study
FPA	Federal Power Act
FirstLight	FirstLight Hydro Generating Company
FCD	Franklin Conservation District
FRCOG	Franklin Regional Council of Governments
FCRP	Friends of the Connecticut River Paddlers
FRR	Full River Reconnaissance
FSF	Four Star Farms
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPD	gallons per day
GPS	global positioning system
HEC-RAS	Hydraulic Engineering Center- River Analysis System
HPMP	Historic Properties Management Plan
HSI	Habitat Suitability Index
IFIM	Instream Flow Incremental Methodology
IHA	Indicators of Hydrologic Alteration
ILP	Integrated Licensing Process
ISO-NE	ISO New England
KPC	Keith Paper Company
kW	kilowatt
kWH	kilowatt-hour
LCCLC	Landowners and Concerned Citizens for License Compliance
LIS	Long Island Sound
m	meter
MA	Massachusetts
MAEOEEA	Massachusetts Executive Office of Energy and Environmental Affairs
MAFBF	Massachusetts Farm Bureau Federation Inc.
MADFW	Massachusetts Division of Fish and Wildlife
MAWMA	Massachusetts Water Management Act
MADEP	Massachusetts Department of Environmental Protection
MBI	Midwest Biodiversity Institute
MESA	Massachusetts Endangered Species Act
mi	mile
mg	milligram

MGD	million gallons per day
MHC	Massachusetts Historical Commission
MIPAG	Massachusetts Invasive Plant Advisory Group
mi^2	square miles
ml	milliliter
msl	mean sea level
MVA	megavolt ampere
MW	megawatt
MWH	megawatt-hour
NEPA	National Environmental Policy Act
NEE	New England Environmental
NEF	New England Flow
NEFU	New England Farmers Union
NEIWPCC	New England Interstate Water Pollution Control Commission
NH	New Hampshire
NHDES	New Hampshire Department of Environmental Services
NHDHR	New Hampshire Division of Historic Resources
NHESP	Natural Heritage and Endangered Species Program
NHFGD	New Hampshire Fish and Game Department
NID	National Inventory of Dams
Northfield Mountain Project	Northfield Mountain Pumped Storage Project
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NHESP	Natural Heritage and Endangered Species Program
NOI	Notice of Intent
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit
NEBA	New England Biking Association
NU	Northeast Utilities
NWI	National Wetland Inventory
OHWM	Ordinary High Water Mark
PAD	Pre-Application Document
PCBs	polychlorinated biphenyls

PHABSIM	Physical Habitat Simulation Model
PIT	Passive Integrated Transponder
PSP	Proposed Study Plans
PVPC	Pioneer Valley Planning Commission
QAPP	Quality Assurance Project Plan
RM	River mile
RRA	River Residents Association
RSP	Revised Study Plans
RTE	Rare, Threatened, and Endangered
RTK	real time kinematic
S&A	Simons and Associates
SAV	submerged aquatic vegetation
SCORP	State Comprehensive Outdoor Recreation Plan
SD1	Scoping Document 1
SGCN	Species of Greatest Conversation Need
SHPO	State Historic Preservation Officer
TCP	traditional cultural properties
SSC	suspended sediment concentration
TDS	total dissolved solids
TFC	Turners Falls Company
TMDL	Total Maximum Daily Load
THPO	Tribal Historic Preservation Officer
TN	total nitrogen
TNC	The Nature Conservancy
TP	total phosphorus
TSS	total suspended solids
Turners Falls Project	Turners Falls Hydroelectric Project
UMass	University of Massachusetts at Amherst
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VANR	Vermont Agency of Natural Resources
VT	Vermont
VTDEC	Vermont Department of Environmental Conservation

VTFWD	Vermont Fish and Wildlife Department
VRC	Vermont River Conservancy
VY	Vermont Yankee Nuclear Power Plant
WMECO	Western Massachusetts Electric Company
WMA	Wildlife Management Area
WPA	Wetlands Protection Act
WSEL	Water Surface Elevation
WUA	Weighted Usable Area
YOY	young-of-the-year

1.0 INTRODUCTION

FirstLight Hydro Generating Company (FirstLight) has initiated with the Federal Energy Regulatory Commission (FERC or Commission) the process of relicensing the 67.709-megawatt (MW) Turners Falls Hydroelectric Project (Turners Falls Project) and the 1,119.2 MW Northfield Mountain Pumped Storage Project (Northfield Mountain Project) (see Figure 1.0-1). FirstLight is applying for license renewal using the FERC's Integrated Licensing Process (ILP). The license for the Turners Falls Project was issued on May 5, 1980 and expires on April 30, 2018. The license for the Northfield Mountain Project was issued on May 14, 1968 and also expires on April 30, 2018.

As part of the ILP, FERC conducted a public scoping process during which various resource issues were identified. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with the FERC. The PAD included FirstLight's preliminary list of proposed studies. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the FirstLight Projects. In accordance with the FERC regulations, site visits typically occur at the same time as the scoping meetings. However, in this case, FERC accelerated the timing of the site visits to avoid a winter site visit to afford an opportunity for on-water tours. Thus, FERC held site visits of the Turners Falls Project, Northfield Mountain Project, on-water Turners Falls Impoundment and the upper reservoir on October 4, 5, and 11. Per the FERC regulations, written comments on the PAD and SD1, and formal study requests must be filed with FERC no later than March 1, 2013. Appendix A contains all of the stakeholder letters that were submitted.

Table 1.0-1, appearing at the end of this section, is a brief summary of the stakeholders that submitted comments, their affiliation, the type of filing[1], whether the filing addressed the FERC study request criteria, and the submittal date. FirstLight also received various comments/concerns that were not in the form of an official study request. These comments/concerns are summarized, along with a response, in Appendix B.

FirstLight received over 200 study requests, although many were duplicative and several had common elements. Where possible, FirstLight consolidated common themes and elements into the same study plan resulting in 36 individual proposed study plans (PSP). Table 1.0-2 shows by resource category the PSP number, PSP title, the stakeholder name along with their study request number in parenthesis, whether FirstLight proposed to conduct the study or not (yes or no), and when the study is proposed (year). This table can be used to map where a stakeholder request falls into a given PSP or if it was not proposed. FirstLight plans on reviewing this table at the May 14, 2013 morning meeting.

In response to feedback from stakeholders during the scoping process, FirstLight is proposing additional studies and information gathering efforts for the Turners Falls Project and Northfield Mountain Project.

More detailed information on each proposed study is provided in Section 3 of this document. Each PSP includes the following sections per the FERC regulations:

- General description of proposed study;
- Study goals and objectives;

[1] The FERC filings in Table 1.0-1 fell under one of three topics: 1) testimonials and information presented at the Scoping Meetings, 2) comments, issues and information submitted to FERC, or 3) study requests that met the FERC study criteria in accordance with 18 CFR § 5.9(b)(1)-(7).

- Resource management goals of agencies/tribes with jurisdiction over resource;
- Existing information and the need for additional information;
- Nexus between project operations and effects on the resource to be studied;
- Study methodology [including study area];
- Level of effort and cost; and
- Schedule.

Additionally, Section 4 of this document describes study requests that FirstLight did not adopt. FirstLight's rationale for why certain study requests were not adopted is also provided. In many instances, the proposed study did not have a nexus to project operations and effects and would not inform the development of license requirements. In other cases, less costly methodologies were available to gather the requested information.

As noted above, pursuant to 18 C.F.R. § 5.11, FirstLight was required to hold a study plan meeting or meetings for the purpose of clarifying the PSP and any initial information gathering or study requests, and to resolve any outstanding issues with the respect to the PSP. On April 5, 2013, FirstLight filed with FERC a meeting schedule to discuss the PSP. FirstLight held a Study Plan Meeting on May 14, 2013 in which all of the proposed studies and studies not being proposed were briefly discussed. Thereafter, FirstLight held nine resource-specific study plan meetings to allow for more detailed discussions on each proposed study plan and on studies not being proposed. With respect to the study plan, FirstLight and the stakeholders focused on working out details primarily on study methodology. The nine meetings were held on May 14, 15, 21, and 22, and June 4, 5, 11, 12 and 14. The meeting dates and agendas are summarized in Table 1.0-3. FirstLight agreed at these meetings to update the PSP and file a single ***Updated PSP*** with FERC. Changes made to this ***Updated PSP*** are shown in track change such that stakeholders can readily view the changes.

Table 1.0-1: Stakeholder Letters filed with FERC

Name	Representing	Filing type			Date Filed
		Testimony	Comments, Concerns, or Information submitted to FERC	Did Study Request address FERC's criteria	
Leena Newcomb	The River Residents Association (RRA)	x			1/31/2013
Jennifer Tufts	Northfield Open Space Committee		x	No	1/31/2013
Thomas and Patricia Shearer	Public		x	No	1/31/2013
Warren Ondras	Public			Yes	1/31/2013
Board of Selectman	Town of Montague		x	No	2/6/2013
Mike Bathory, Alan Wallace	Landowners and Concerned Citizens for License Compliance (LCCLC)	x			2/11/2013
Mary Joe Maffei, Manager	Manager of Amherst High School Nordic Ski Team		x	No	2/16/2013
• Peter Conway • Stanley and Geri Johnson • Robert and Linda Emond • Walter and Mary Ann Patenaude • Michael and Diane Kane • Cynthia Dale • Robert Strafford and Family • Leena Newcomb • Vivien Venskowski • Betsy and Jean Egan	RRA		x	No	2/16/2013-3/1/2013
Nathan L'Etoile, Co-Owner	Four Star Farms (FSF)		x	No	2/20/2013
Jeffrey Squire, President	Western Massachusetts Climbers' Coalition		x	No	2/20/2013
Board of Selectman	Town of Montague		x	No	2/21/2013
Bill Llewelyn, Chair	Town of Northfield Conservation Commission (NCC)		x	No	2/22/2013
Barbara Skuly, Chairman	Ashuelot River Local Advisory Committee (ARLAC)		x	No	2/24/2013
Karl Meyer	Public		x	No	2/25/2013
Richard Bonanno, Director	Massachusetts Farm Bureau Federation, Inc (MFBF)		x	No	2/25/2013
River Resident (no name given)	Public		x	No	2/26/2013
Louis Chiarella, Mary Colligan	National Marine Fisheries Service (NMFS)			Yes	2/27/2013
Glen Normandeau, Executive Director	New Hampshire Fish and Game Department (NHFG)			Yes	2/27/2013
Caleb Slater, Thomas French	Massachusetts Division of Fisheries and Wildlife (MADFW), Natural Heritage and Endangered Species Program (NHESP)			Yes	2/28/2013
Chris Curtis	Public		x	No	2/28/2013
Ken Kimball, Norm Sims	Appalachian Mountain Club (AMC)		x	No	2/28/2013
Ken Kimball, Norm Sims, Bob Nasdor, Thomas Christopher	AMC, American Whitewater Association (AWWA), New England Flow (NEF)			Yes	2/28/2013
Dr. Richard Palmer	University of Massachusetts at Amherst (UMass)		x	No	2/28/2013
Carolyn Shores Ness, Vice Chair	Franklin Conservation District (FCD)			Yes	2/28/2013
Ken Kimball, Norm Sims, Noah Pollock, Stephan Syz	AMC, Vermont River Conservancy (VRC), Friends of the Connecticut River Paddlers (FCRP)			Yes	2/28/2013
Kevin Mendik	National Park Service (NPS)			Yes- not exact	2/28/2013
Joseph Graveline, President	The Nolumbeka Project, Inc		x	No	2/28/2013
Bill Perlman, Jerry Lund, Tom Miner	Franklin Regional Council of Governments (FRCOG)		x	Yes	3/1/2013
Mike Bathory	LCCLC			No	3/1/2013
Gill Selectboard	Town of Gill		x	Yes	3/1/2013

Name	Representing	Filing type			Date Filed
		Testimony	Comments, Concerns, or Information submitted to FERC	Did Study Request address FERC's criteria	
Robert Kubit	Massachusetts Department of Environmental Protection (MADEP)		x	Yes	3/1/2013
Roger Noonan, President	New England Farmers Union (NEFU)		x	No	3/1/2013
Don Pugh	Deerfield River Chapter of Trout Unlimited (DRTU)			Yes	3/1/2013
Rebecca Brown, President	Connecticut River Joint Commissions (CRJC)			Yes	3/1/2013
Elizabeth Muzzey, Director and State Historic Preservation Officer	New Hampshire Division of Historical Resources (NHDHR)		x	No	3/1/2013
Brian Fitzgerald, Streamflow Protection Coordinator	Vermont Department of Environmental Conservation (VTDEC)			Yes	3/1/2013
Gregg Comstock, PE, Supervisor, Water Quality Planning	New Hampshire Department of Environmental Services (NHDES)			Yes	3/1/2013
Kim Lutz, Director, Kathryn Mickett Kennedy, Applied River Scientist	The Nature Conservancy (TNC)			Yes	3/1/2013
Howard Fairman	Public		x	No	3/1/2013
Richard Bonanno, President	Massachusetts Farm Bureau Federation Inc. (MAFBF)		x	No	3/1/2013
Andrea Donlon, River Steward	Connecticut River Watershed Council (CRWC)			Yes	3/1/2013
Stephanie Krug, President	New England Biking Association (NEBA)			Yes	3/1/2013
Stephanie Krug, President	NEBA		x	No	3/1/2013
Tim Welsh	FERC			Yes	3/1/2013
Thomas Chapman, Supervisor	United States Fish and Wildlife Service (USFWS)			Yes	3/1/2013
Joanne McGee	Public		x	No	3/1/2013
Kurt Heidinger, Director	BioCitizens		x	No	3/1/2013
Don Stevens, Chief	Nulhegan Band of the Coosuk- Abenaki Nation		x	No	3/18/2013

Table 1.0-2: Study Request and PSP Matrix

Title	Stakeholder Requester(s)	PSP Section	Proposed	Year
Geology and Soils				
2013 Full River Reconnaissance Study	CRSEC	3.1.1	Yes	2013
Study of Turners Falls Erosion	NHFGD (9); Town of Gill (1); LCCLC (1a); FRCOG (1); FCD (1); NMFS (14); CRWC (1)	(Part of 3.1.1)	Yes	2013
Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability~~Sediment Transport~~	NHFGD (6); Town of Gill (2); LCCLC (2a); FRCOG (3); FCD (2); CRWC (2); MADEP (1)	3.1.2	Yes	2014
Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations	NHDES (21c); VANR (1)	(Part of 3.1.1) (Part of 3.1.2) (Part of 4.1.1)	Partial, see section 4.1.1	2014
Water Resources				
Water Quality Monitoring Study	Proposed in PAD; Town of Gill (5); LCCLC (5a); FRCOG (4); CRWC (6); VANR (2); MADEP (2); USFWS (21); NHDES (25c)	3.2.1	Yes	2014
Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot Station	FERC (1)	3.2.2	Yes	2013-2014
Model River Flows and Water Levels Upstream and Downstream of the Turners Falls Project Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations	NHFGD (16); LCCLC (8a); FRCOG (6); MADFW (13); NMFS (1); CRWC (7); NHDES (14a); USFWS (1); TU (12)	(Part of 3.2.2) (Part of 3.8.1)	Yes	2013-2015
Watershed-wide Stormwater Model	CRJC (Attachment B, pdf page 7)	4.2.1	No	NA
Aquatic Resources				
Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	NHFGD (19); MADFW (2); NMFS (2); CRWC (11); TU (13); USFWS (2); NHFGD (20); MADFW (1); NMFS (3); CRWC (12); TU (14); USFWS (3); TNC (2)	3.3.1	Yes	Accelerated 2013
Evaluate Upstream and Downstream Passage of Adult American Shad	NHFGD (1); Town of Gill (8); NMFS (7); CRWC (14); NHDES (2); VANR (12); TU (2); USFWS (6); MADFW (3); FERC (5)	3.3.2	Yes	2014
Evaluate Downstream Passage of Juvenile American Shad	NHFGD (21); Town of Gill (13); MADFW (6); NMFS (8); CRWC (16); VANR (9); TU (15); USFWS (9)	3.3.3	Yes	2014
Evaluate Upstream Passage of American Eel at the Turners Falls Project	NHFGD (11); MADFW (7); NMFS (9); CRWC (18); VANR (22); TU (8); USFWS (14)	3.3.4	Yes	2014-2015
Evaluate Downstream Passage of American Eel	NHFGD (4); MADFW (8); NMFS (10); CRWC (20); VANR (21); TU (5); USFWS (16)	3.3.5	Yes	2015
Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River	NHFGD (2); MADFW (9); CRWC (19); NHDES (3); VANR (20); TU (4); USFWS (15)	(Part of 3.3.5)	Yes	2014
Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in Area of the Northfield Mountain and Turners Falls Projects	NHFGD (3); Town of Gill (9); MADFW (4); NMFS (5); CRWC (15); NHDES (4); VANR (11); USFWS (5); TU (3); NMFS (5)	3.3.6	Yes	2014, possibly 2015
Fish Entrainment and Turbine Passage Mortality Study	NHFGD (8); Town of Gill (14); MADFW (12); NMFS (13); CRWC (23); TU (7); USFWS (12), FERC (4)	3.3.7	Yes	2015
Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays	NHFGD (13); MADFW (10); NMFS (12); CRWC (10); TU (10); USFWS (8)	3.3.8	Yes	2014
Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace	NHFGD (7); Town of Gill (7); LCCLC (7a); MADFW (11); CRWC (4); TU (6); USFWS (13)	3.3.9	Yes	2014
Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	MADFW (22)	3.3.10	Yes	2014
Fish Assemblage Assessment	NHFGD (15); Town of Gill (11); CRWC (8); FERC (3); TNC (4); VANR (13); TU (11); USFWS (17); MADFW (21)	3.3.11	Yes	2014
Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Spill Events on Shortnose Sturgeon Spawning and Rearing Habitat	NHFGD (14); NMFS (4); CRWC (25); USFWS (4)	3.3.12	Yes	2014, possibly 2015
Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Spawning and Spawning Habitat	MADFW (15); USFWS (18);NHFGD (18); Town of Gill (12); CRWC (9); VANR (18)	3.3.13	Yes	2014
Aquatic Habitat Mapping of Turners Falls Impoundment	FERC (2)	3.3.14	Yes	2014
Assessment of Adult Sea Lamprey Spawning within the Turners Falls Impoundment and Northfield Mountain Project Area	NMFS (11)	3.3.15	Yes	2014
Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot station	MADFW (20)	3.3.16	Yes	Portions in 2013, if possible; 2014
Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitats	NHFGD (5); Town of Gill (10); MADFW (14); CRWC (21); VANR (19); USFWS (19)	3.3.17	Yes	2014
Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	NHFGD (12); MADFW (17); NMFS (6); CRWC (24); TU (9); USFWS (11)	3.3.18	Yes	2014-2015
Evaluate the Use of an Ultrasound Array to Facilitate Upstream Shad Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace.	NHFGD (22); CRWC (17); USFWS (7)	3.3.19	Yes	2015

Title	Stakeholder Requester(s)	PSP Section	Proposed	Year
Shad Population Model for the CT River	NHFGD (10); MADFW (5); CRWC (13); NHDES (6); TU (1); USFWS (10)	4.3.1	No	NA
Terrestrial Resources				
Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, the Bypass Reach and below Cabot Station	Proposed in PAD	3.4.1	Yes	2014
Wildlife Habitat Assessment of Bypass	Montague Board of Selectmen	(Part of 3.4.1)	Yes	2014
Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats	FERC (8)	3.4.2	Yes	2014
Wetlands Riparian and Littoral Habitat				
Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species	Incorporates 10 requests below	3.5.1	Yes	2014
Integrate Modeled River Flows and Water Levels with Habitat Assessment for State-Listed Riparian Invertebrate Spp.	MADFW (19)	(Part of 3.5.1)	Yes	2014
Assessing Operational Impacts on State-listed Rare Plants in the CT River	MADFW (23)	(Part of 3.5.1)	Yes	2014
Impacts of Water Level Fluctuations on Riparian and Aquatic Veg. Including Invasive Spp. And their Associated Habitats in the TF Impoundment	NHFGD (17); Town of Gill (6); LCCLC (6a); FRCOG (5); CRWC (22); NHDES (15b); VANR (26); USFWS (20)	(Part of 3.5.1 and 3.3.14)	Yes	2014
Recreation and Land Use				
Recreation Use/User Contact Survey	Proposed in PAD; FERC (6)	3.6.1	Yes	2014
Recreation Facilities Inventory and Assessment	Proposed in PAD; FERC (6)	3.6.2	Yes	Accelerated 2012-13
Whitewater Boating Evaluation	NPS (2); AMC, VRC, FCRPT (2); NEF, AMC, American Whitewater (1); FERC (7)	3.6.3	Yes	2014
Assessment of Day Use and Overnight Facilities Associated with Non-motorized Boats	NPS (1); AMC, VRC, FCRPT (1); NEF, AMC, American Whitewater (2) and (3); Montague Board of Selectmen; AMC; CRWC (26)	3.6.4	Yes	2014
Land Use Inventory	FL proposed in PAD	3.6.5	Yes	2014
Assessment of Effects of Project Operation on Recreation and Land Use	FL proposed in PAD	3.6.6	Yes	2014
Recreation Study at Northfield Mountain, Including Assessment of Sufficiency of Trails for Shared Use	NPS (4); AMC, VRC, FCRPT (4); Citizen(Krug)	3.6.7	Yes	2014
Contingent Valuation Study	NEF, AMC, American Whitewater (4)	4.5.1	No	NA
Mitigation Impacts of the Connecticut River and loss of Whitewater Recreation at and above Turners Falls Dam	NEF, AMC, American Whitewater (5)	4.5.2	No	NA
Aesthetics				
Noise Level Determination for Northfield Mountain Project Operations	Citizen (Ondras)	4.4.1	No	NA
Cultural Resources				
Phase 1A Archeological Survey	Proposed in PAD; Montague Board of Selectmen (2-21-2013); Montague Selectmen (2-25-13); FERC (AIR 2)	3.7.1	Yes	2014
Reconnaissance-Level Historic Structures Survey	Proposed in PAD	3.7.2	Yes	2014
Assess Preservation of Cultural, Historical, and Educational Resources	NPS (3); AMC, VRC, FCRPT (3)	4.6.1	No	NA
Socioeconomics				
Feasibility of Converting the Northfield Mountain Pumped Storage Facility to a Closed-Loop or Partially Closed-Loop System	Town of Gill (3); LCCLC (3a); FRCOG (2); FCD (3); CRWC (3)	4.7.1	No	NA
Creation of a Decommissioning Fund	NPS (5); AMC, VRC, FCRPT (5)	4.7.2	No	NA
Other				
Climate Change and Continued Project Operations	Town of Gill (4); LCCLC (4a); MADFW (18); CRWC (5); NHDES (27); USFWS (22)	4.2.2	No	NA
Development Resources				
Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation	Proposed in PAD; TNC (1)	3.8.1	Yes	2013-2015, updated with data from other studies
Develop and Comprehensive and Predictive Model of Electrical Generation System Consisting of 5 Generation Projects along the CT River; Study the Impact and Feasibility of Various Changes in operations on Environmental Resources	FRCOG (7)	(Part of 3.8.1)	Yes	2013-2015, updated with data from other studies

Table 1.0-3: Post PSP Filing Meeting Dates and Agendas

No.	Name	Date	Time
Water Resources			
3.2.1	Water Quality Monitoring Study	May 14	1:00 pm
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot		1:30 pm
Developmental Resources			
3.8.1	Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation and Hydropower Generation		2:15pm
4.2.1	*Watershed Wide Stormwater Model*		3:00 pm
4.2.2	*Climate Change and Continued Project Operations*		3:30 pm
Developmental Resources and Geology and Soil Resources			
4.7.1	*Feasibility of Converting the Northfield Mountain Pumped Storage Project to a Closed-Loop or Partially Closed Loop System*	May 15	9:00 am
4.7.2	*Creation of a Decommissioning Fund*		9:30 am
3.1.1	2011 Full River Reconnaissance		10:00 am
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability		1:00 am
4.1.1	*Study of Shoreline Erosion caused by Northfield Mountain Pumped Storage Project Operations*		3:00 pm
4.1.2	*Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River*		3:30 pm
Fish and Aquatic Resources and Terrestrial Resources			
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	May 21	9:00 am
3.3.19	Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace		11:00 am
3.3.8	Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays		1:00 pm
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace		2:00 pm
3.3.12	Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station		3:00 pm
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	May 22	9:00 am
3.3.6	Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects		9:30 am
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat		11:00 am
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area		1:00 pm
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat		2:00 pm
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms		3:00 pm
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls	June 4	9:00 am
3.3.3	Evaluate Downstream Passage of Juvenile American Shad		10:00 am
3.3.5	Evaluate Downstream Passage of American Eel		11:00 am
3.3.7	Fish Entrainment and Turbine Passage Mortality Study		1:00 pm
4.3.1	*Shad Population Model for the Connecticut River*		3:00 pm
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	June 5	9:00 am
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station		10:00 am
3.3.11	Fish Assemblage Assessment		11:00 am
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, the Bypass Reach and below Cabot Station within the Project Boundary		1:00 pm
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats		2:00 pm
3.5.1	Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species		3:00 pm
Recreation, Land Use, Aesthetics and Cultural Resources			
3.6.2	Recreation Facilities Inventory and Assessment	June 11	9:00 am
3.6.1	Recreation Use/User Contact Survey		9:45 am
3.6.3	Whitewater Boating Evaluation		10:30 am
4.5.1	*Contingent Valuation Study*		1:00 pm
4.5.2	*Mitigation Impacts of the Connecticut River and Loss of Whitewater Recreation at and above Turners Falls Dam*		1:30 pm
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats		2:00 pm

No.	Name	Date	Time
3.6.7	Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use		3:00 pm
3.6.5	Land Use Inventory	June 12	9:00 am
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use		10:00 am
3.7.1	Phase 1A Archaeological Survey		11:00 am
3.7.2	Reconnaissance-Level historic Structures Survey		1:00 pm
4.6.1	*Assess Preservation of Cultural, Historical and Educational Resources*		2:00 pm
4.4.1	*Noise Level Determination for Northfield Mountain Project Operations*		2:30 pm
Geology and Soil Resources (Round 2)			
3.1.1	2011 Full River Reconnaissance	June 14	9:00 am
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability		11:00 am

Studies in *italics* are not being proposed.

FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

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Figure 1.0-1
Turners Falls Project and Northfield Mountain Project Boundary Map

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2.0 FERC ISSUED PAD DEFICIENCIES AND ADDITIONAL INFORMATION REQUESTS

In addition to making their study requests, FERC issued PAD deficiencies as well as additional information requests (AIRs) to supplement the content of the PAD. These deficiencies and AIRs are addressed below.

2.1 FERC PAD Deficiencies

2.1.1 Project Facilities and Operation (FERC Deficiency #1a and #1b)

FERC Def #1a: Please provide the dependable capacity of the Turners Falls Project and the Northfield Mountain Pumped Storage Project and the basis for the determination of the dependable capacity as required per § 5.6(d)(2)(iii)(E) of the regulations.

FirstLight Response: According to *Civil Engineering Guidelines for Planning and Designing Hydroelectric Developments* published by the American Society of Civil Engineers in 1989, dependable capacity is defined as "*the load-carrying ability of a power plant under adverse load and flow conditions.*" For a standard hydroelectric facility, these conditions would be present during a period of high electrical demand and low flow.

The contracted capacity for the Turners Falls Project with ISO-New England is 68.2 MW (61.8 MW at Cabot and 6.4 MW at Station No. 1). If there were no storage capacity in the Turners Falls Impoundment, the dependable capacity would be lower and would be based on the lowest flow period, which occurs in September (see Figure page 4-30 of the PAD). The highest electrical demand months were estimated from Northfield generation data (see Page 3-33 of PAD) as a true indicator of demand or "adverse load". For the period 2000-2009, September was the third highest generation (demand) month, behind July and August. For purposes of this analysis, it was assumed that September reasonably represents a low flow/high demand period. The September median flow at the Turners Falls Dam for the period 1941 to 2010 is approximately 4,008 cfs (see page 4-30 of PAD). Assuming all 4,008 cfs is passed through Cabot Station under a net head of approximately 60 feet; the estimated dependable capacity of the Turners Falls Project (without storage capacity) would be approximately 17.7 MW.

The contracted capacity for the Northfield Mountain Project with ISO-New England is 1,124.0 MW, which assumes a full upper reservoir.

FERC Def #1b: Please provide land use maps which include key features as required per § 5.6(d)(2)(ii) of the regulations.

FirstLight Response: Land cover maps were included in the PAD on a larger scale in Figure 4.1.1-1. Land use data is readily available in Massachusetts through the Mass-GIS; land use data is not available for New Hampshire or Vermont. Figure 2.1.1 (a-g) provides a series of land use maps on a smaller scale than that provided in the PAD.

2.1.2 Geology and Soils (FERC Deficiency #2a, #2b, and #2c)

FERC Def #2a: The PAD describes the soils and occurrences; however, it does not provide descriptions of chemical characteristics, erodibility and potential mass movement as required by § 5.6(d)(3)(ii)(B) of the Commission's regulations. Therefore, to the extent known, please provide a description of chemical characteristics, erodibility and potential mass movement of soils in each project's area.

FirstLight Response: Section 4.2.3 of the PAD contains a discussion of soil types and mapping from Vernon Dam to the Cabot tailrace including the identification of the ten most common soil series found in the Project boundary (PAD Table 4.2.3-1). Although general characteristics of each soil series were included in the PAD, quantitative data pertaining to the chemical and physical properties and erodibility were not discussed. As such, please find the following enclosed in Appendix C:

- Chemical properties including cation-exchange capacity, effective cation-exchange capacity, and pH;
- Physical properties including percent sand, silt, and clay, saturated hydraulic conductivity, organic matter, and erosion factors (Kw, Kf, and T factors); and
- Potential erosion hazard

Soil erodibility factors contained in Appendix C include both the K and T factors. K factor values typically range from 0.02 (least erodible) to 0.64 (most erodible) and can be divided into two sub-categories, Kw and Kf factors. The Kw factor is calculated by taking into consideration the whole soil, while the Kf factor only considers the fine-earth fraction (<2.0 mm diameter). Soil properties affecting the K factor, and therefore the erodibility, can include texture, organic matter content, structure, infiltration, and permeability. The T factor is the maximum amount of annual sheet and rill erosion that permits the fertility and productive capacity of the soil to be maintained indefinitely. T factor values range from 1 ton per acre per year for the most fragile soils, to 5 tons per acre per year for soils that can sustain more erosion without significant productive rainfall. Soil properties affecting T factor values include texture, permeability, available water capacity, and depth to restrictive layer such as rock, clay, or gravel (NRCS, 2013, http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm). Data included in Appendix C is parsed based on soil profile depth.

In addition to the NRCS data referenced above, FirstLight has conducted years of river bank erosion studies along the Turners Falls Impoundment resulting in numerous filings with the FERC. As part of the Erosion Control Plan, FirstLight has conducted Full River Reconnaissance (FRR) surveys every 3-5 years since 1998. During these surveys, information such as bank height, bank slope, bank erosion, bank material, and degree of vegetation is collected. In addition to the FRRs, FirstLight recently filed long term monitoring transects within the Turners Falls Impoundment showing geomorphic changes over the last 10+ years. Thus, very specific information on erodibility is contained in these reports.

FERC Def #2a: Additionally, section 5.6(d)(3)(ii)(C) specifies that the PAD provide information on the erosion within the project area. However, while the PAD provides information on erosion around the Turners Falls reservoir, it did not provide any information on the presence of erosion, mass soil movement, slumping or other forms of instability along the bypass reach or the project's power canal. Therefore, pursuant to section 5.6(d)(3)(ii)(C)(2) of the Commission's regulations please provide a description of all known erosion sites within the Turners Falls project's bypass reach and/or along its power canal, and to the extent known, a determination as to the cause of the erosion. The description of each site should include the length of shoreline affected by erosion, the height of the eroded area, and the soil type.

FirstLight Response: FirstLight performed an aquatic mesohabitat study that encompassed the Turners Falls Bypass Reach during 2012. This work entailed walking the bypass reach from the Turners Falls Dam to the Cabot tailrace. The substrate within the bypass reach is primarily bedrock controlled with few areas containing fine substrate; the river-right embankments are naturally armored, high and steep-sided. The river-left embankments are primarily lined with buildings. No areas along the bypass reach river banks were found to be eroding.

FirstLight conducts annual inspections of the power canal in a partially dewatered state every September. During 2007-2009, Kleinschmidt Associates investigated an area within the Turners Falls power canal where a slough had formed along the eastern dike (about 400 feet downstream of where the power canal begins to widen) and actions to fix the issue were taking place. The erosion responsible for creating the slough was attributed to considerable sediment buildup toward the western side of the canal, which caused the water velocity along the east bank to be higher than originally intended. The original depth of the west side of the canal was 14 feet, but the sediment accumulation since the canal was built had created a large area where the depth was shallow enough for geese to stand. Additionally, the scouring in the vicinity of the slough was 17 feet below the water level of the canal during dewatering inn 2007; by 2008, the scoured hole was 20 feet deep. Removal of sediment from the west bank to the scoured area, along with the addition of stone to stabilize the sediments, resulted in the hole being filled with 42,700 cubic yards (CY) of fill. It was concluded that the work completed in 2009 was a success, with improved flow distribution and lower velocities along the eastern dike. Also, armoring likely increased the stability of the dike with reduced potential for future sloughing. A 300 foot long section of scour at the downstream end of the filled in area was not considered a priority due to being shallow and was not filled in; it is a potential location for future redistribution of silt. A report was filed by Kleinschmidt Associates ("Canal Maintenance Completion Report", July 2009) under Critical Energy Infrastructure Information (CEII).

FERC Def #2b: As specified in § 5.6(d)(3)(ii)(C), please provide a description of reservoir shorelines within the Northfield Mountain upper reservoir. The description should include a description of soils, geometry, and existing armoring and stabilization measures.

FirstLight Response: The shoreline of the Northfield Mountain Reservoir is approximately 3.5 miles long. The majority of the shoreline is the rockfill embankment, but there are also four natural ridges. The 3.5 mile shoreline is comprised of approximately 2.2 miles of rockfill embankment, 0.8 miles of more natural (primarily udorthents, or human disturbed) soils and 0.5 miles of excavated bedrock (near the intake). The United States Department of Agriculture's online Web Soil Survey application was queried for soil identification and description, for the approximately 0.8 miles of udorthent soil. An area at the northern end of the reservoir is identified as Woodstock-Millsite-Rock outcrop complex. This soil, which comprises about 1,000 feet of the shoreline, consists of very rocky and rocky soils and rock outcrop. The Soil Survey Report also identified an area about 1800 feet long on the west shore and an area about 1400 feet long on the northeast shore, along natural ridge areas, which consist of generally very fine sand to fine sandy loam. There is some grass and other low growing vegetation on the north shore and west shore areas identified above. The northeast shore area is generally free of vegetation. The upstream face of the embankment consists of large stone fill, with an overall slope of approximately 1:1.8 (V:H), though the upper portion of the slope is somewhat steeper at about 1:1.5 (V:H). There is little to no vegetation growing along this portion of the shoreline, except at very low elevations in some areas, where sediment has deposited.

The upper reservoir, intake channel and intake structure are in the Dry Hill gneiss, which is quite durable and hard rock material. The rocks comprising the west flank of the Northfield Mountain are part of the hard crystalline metasedimentary complex. Near the crest of the mountain, the Dry Hill granite gneiss crops out with the average layering dips from 10° to 12° to the N68°W. Stratification around the project suggests that the ancient sedimentary sequence was metamorphosed by intrusive sills, perhaps from the east. Past studies have indicated that the Dry Hill is considered as an igneous unit, which intrudes the Poplar Mountain formation. The upper portion of the Dry Hill appears to be much less highly metamorphosed, with massive strata separated by thin interbeds of dark biotite and hornblende. Additional information on the geology of the Northfield Mountain Project is included in Section 4.2.2 of the PAD.

FERC Def #2c: As specified in § 5.6(d)(3)(ii)(B), please provide a description of the sediment management in the Northfield Mountain upper reservoir, including monitoring, removal and disposal.

FirstLight Response: On February 15, 2012 FirstLight submitted for FERC approval a *Sediment Management Plan* for the Northfield Mountain Project. As part of this plan, FirstLight has committed to monitoring suspended sediment concentration in the Northfield Mountain Project intake and discharge under a range of operating and ambient river conditions; monitor suspended sediment concentration in the Turners Falls Impoundment at the Route 10 Bridge under a range of flow and water level elevation conditions; conduct bathymetric mapping of the upper reservoir to estimate annual sediment accumulation rates and locations; and, at the end of the monitoring period (2015) propose measures to address the entrainment of sediment into the Project works during upper reservoir drawdown or dewatering activities. For a detailed description of sediment monitoring activities please refer to the *Sediment Management Plan*[2].

2.1.3 Water Resources (FERC Deficiency #3)

FERC Def #3: Please provide the Northfield Mountain upper reservoir maximum, minimum and mean depth as well as the shoreline length as required per § 5.6(d)(3)(iii)(H) of the regulations.

FirstLight Response: As described in Section 3.2.2 of the PAD, the upper reservoir has a gross storage capacity of 17,050 acre-feet and a surface area of approximately 286 acres at a water surface elevation of 1000.5 feet. The mean depth is calculated to be 59.6 feet. Based on the most recent bathymetric survey of the upper reservoir conducted in 2012, the maximum depth in the upper reservoir is approximately 120 feet when the reservoir is full.

The shoreline of the upper reservoir is approximately 3.5 miles long.

2.1.4 Recreation and Land Use (FERC Deficiency #4)

FERC Def #4: For Turners Falls Fishway Viewing Area and Bennett Meadow Wildlife Management Area (WMA) please address the ownership information as specified in § 5.6 (d)(3)(viii)(A).

FirstLight Response: FirstLight owns in fee the Turners Falls Project fish viewing area and the Bennett Meadows Wildlife Management Area.

2.1.5 Aesthetic Resources (FERC Deficiency #5)

FERC Def #5: The PAD did not provide information on the description of aesthetic and visual characteristics of the Turners Falls Project dam and adjacent facilities as required by § 5.6(d)(3)(ix). Please provide this information with accompanying photos (if available).

FirstLight Response: As described in Section 3.2.1 of the PAD, the Turners Falls Dam consists of two individual concrete dams—Gill Dam and Montague Dam—that are connected by a natural rock island known as Great Island. The 630-foot-long, approximately 35-foot-high Montague Dam connects Great Island to the west bank of the Connecticut River and includes four gates and a fixed crest section, which is normally not overflowed. The Gill Dam is approximately 55 feet high and 493 feet long, extending from the Gill shoreline (east bank) to Great Island, and includes three tainter spillway gates.

[2] FirstLight filed its *Sediment Management Plan* with FERC on July 15, 2011.

The power canal gatehouse is located on the Montague side of the Connecticut River, forming the abutment for connecting the Montague Dam spillway. The structure is approximately 214 feet long and has masonry and reinforced concrete foundations with a brick walled superstructure.

The power canal is approximately 2.1 miles long and ranges in width from approximately 920 feet in the Cabot forebay (downstream terminus of canal) to 120 feet in the canal proper.

An aerial image of the dam, gatehouse, and upstream ends of the power canal and bypass reach is shown in Figure 2.1.5a. The Gill-Montague Bridge just below Turners Falls Dam provides limited views of the dam and bypass reach.

Station No. 1 is located approximately 0.8 miles downstream from the dam along the bypass reach, where it is connected to the power canal via an approximately 700-foot-long by 100-foot-wide branch canal. The powerhouse consists of brick masonry on concrete foundations and has eight intake bays—each 15 feet wide for a total intake width of 120 feet—narrowing to four penstock outlets. Figure 2.1.5b shows a view of Station No. 1 from the bypass reach. The powerhouse can generally only be viewed by the public from the bypass reach (access to the powerhouse is gated).

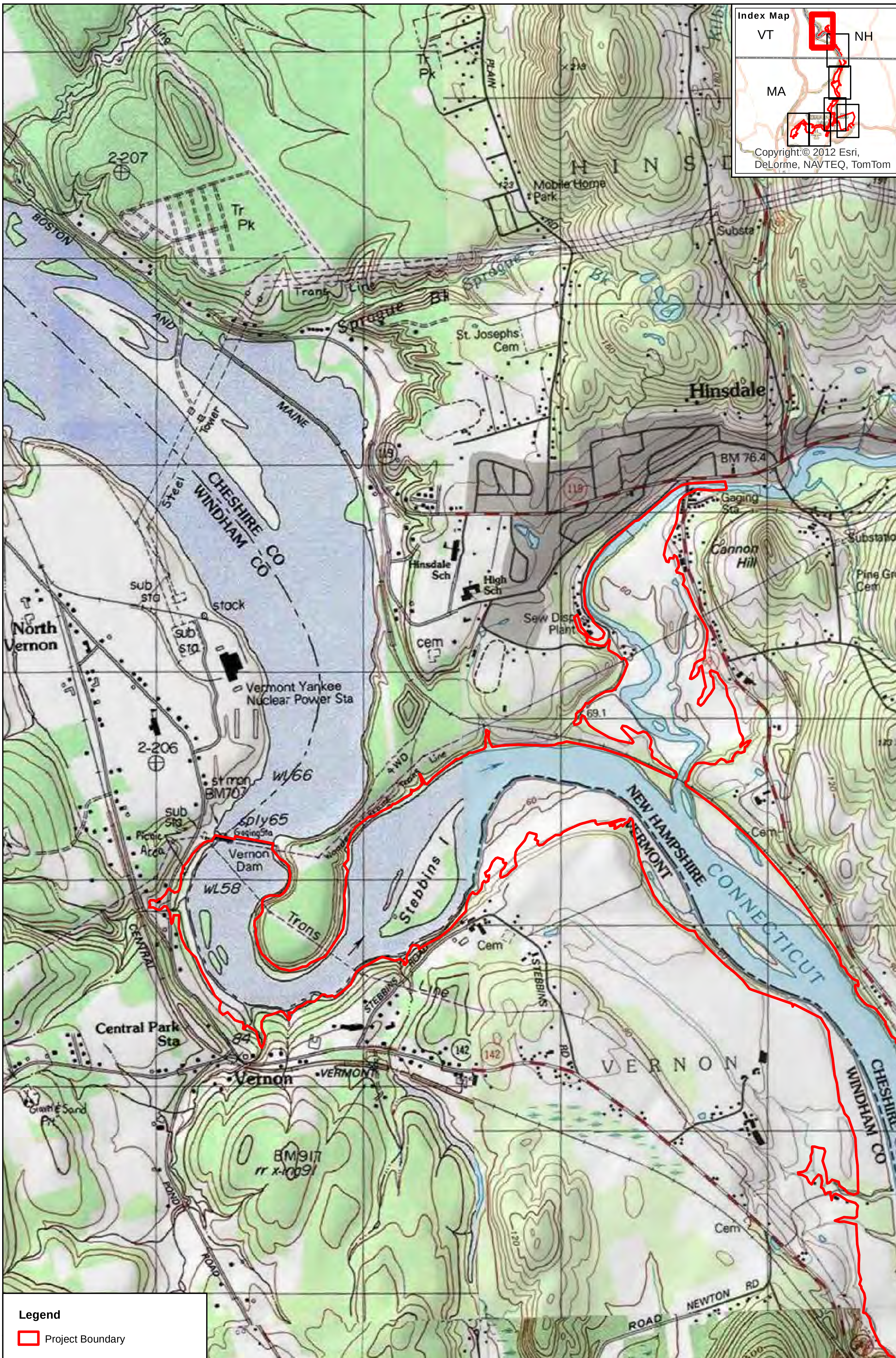
Cabot Station is located at the downstream terminus of the power canal. The powerhouse is a brick and steel structure set on a concrete substructure on a rock foundation, with an intake opening 217 feet wide by 31 feet high. Adjacent to the powerhouse are eight wooden spillway gates. An upstream view of Cabot Station from the Tailwater area is shown in Figure 2.1.5c. As with Station No. 1, the powerhouse can generally only be viewed by the public from the bypass reach (powerhouse access is gated).

2.1.6 Cultural Resources (FERC Deficiency #6)

FERC Def #6: Please provide a description of existing discovery measures for locating, identifying, and assessing the significance of resources as specified in § 5.6(d)(3)(x)(B). Please provide available information on Indian traditional cultural and religious properties as specified in § 5.6(d)(3)(x)(C).

FirstLight Response: FirstLight consults with the applicable State Historic Preservation Office (SHPO), whenever FirstLight proposes to undertake ground-disturbing activity within the Turners Falls Project and Northfield Mountain Project boundaries that require a state or federal permit, in order to locate, identify, and assess the significance of either known or currently unknown cultural resources. In addition, prior to granting permission to others for non-Project uses of Project lands and waters, FirstLight consults with the applicable SHPO in accordance with the procedures of Article 43 of the Turners Falls Project license and Article 52 of the Northfield Mountain Project license. The purpose of such consultation is to determine whether such grants of permission or ground disturbing activity have the potential to adversely affect historic properties.

There are no known Indian traditional cultural properties (TCPs) or religious properties within the Turners Falls Project and Northfield Mountain Project boundaries. One property – The Turners Falls Sacred Ceremonial Hill Site – was determined eligible for inclusion in the National Register of Historic Places as a TCP in 2008. No portion of this ceremonial site is located in either of the Projects' boundaries.



FirstLight Power Resources
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FIRSTLIGHT POWER RESOURCES
PROPOSED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 a
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 1 of 7

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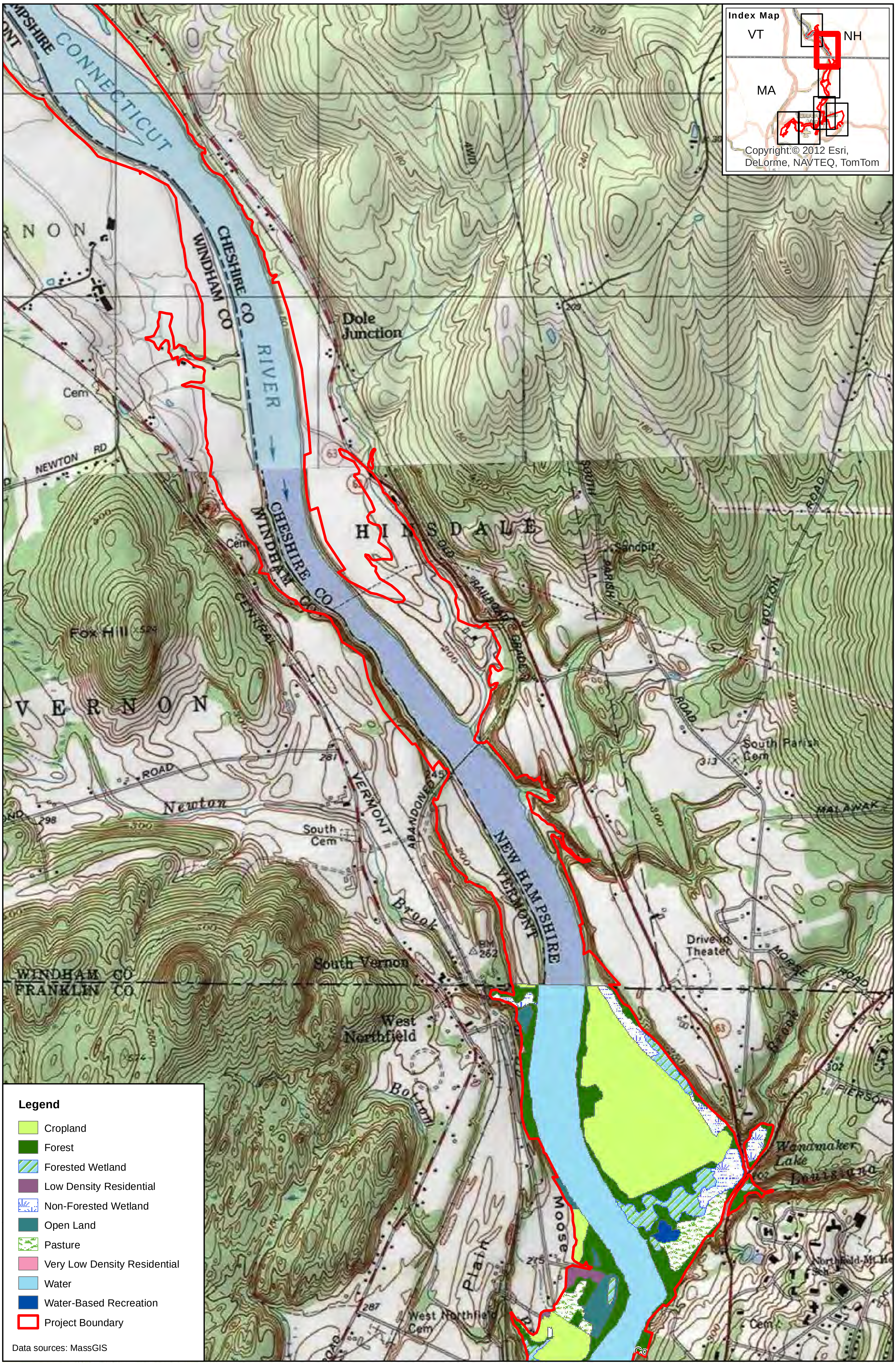

FirstLight Power Resources
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FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 b
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 2 of 7

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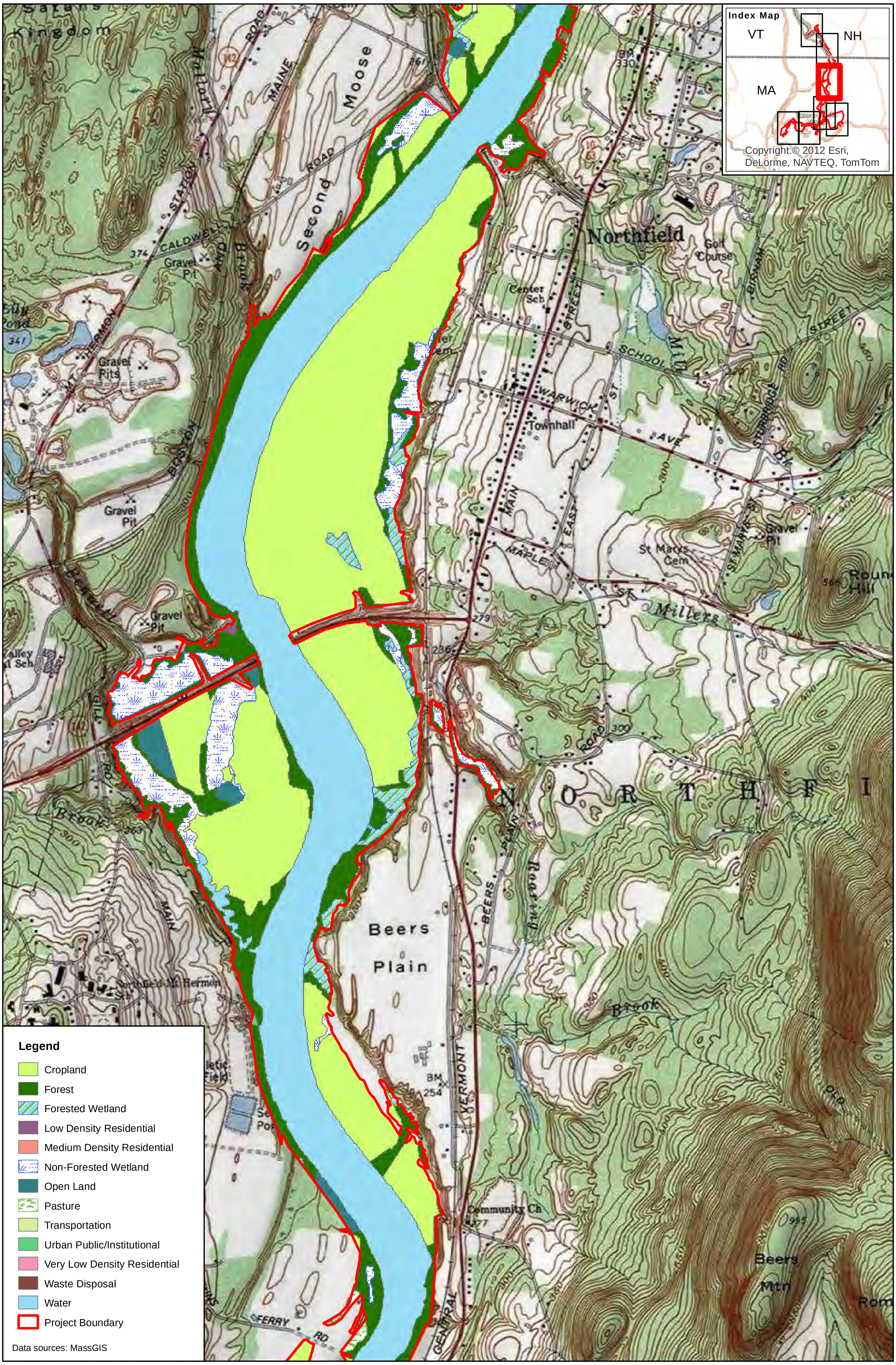

FirstLight Power Resources

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FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 c
Turners Falls Project and Northfield Mountain Project Land Use Maps

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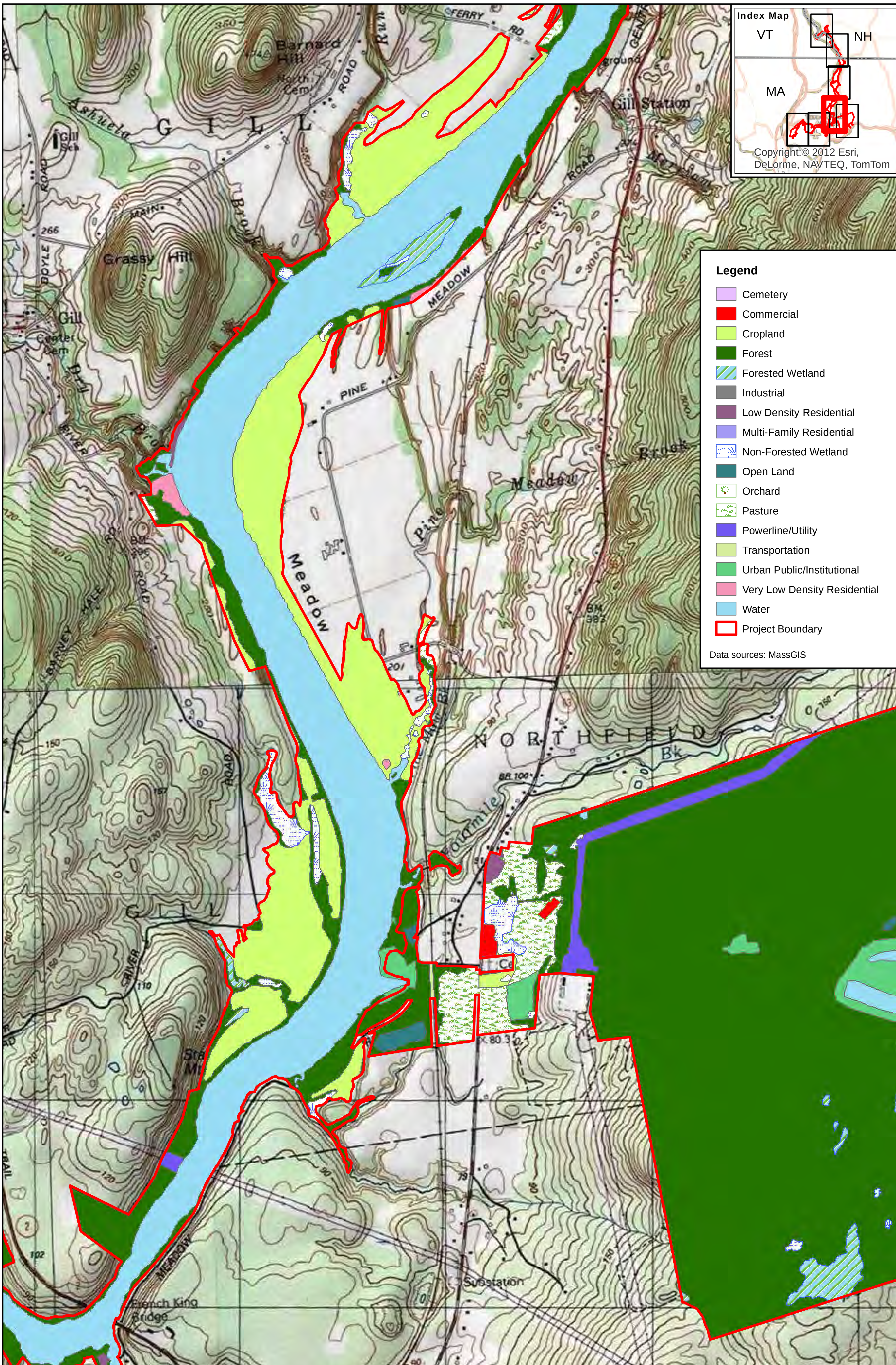

FirstLight Power Resources

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FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 d
Turners Falls Project and Northfield Mountain Project Land Use Maps

Page 4 of 7

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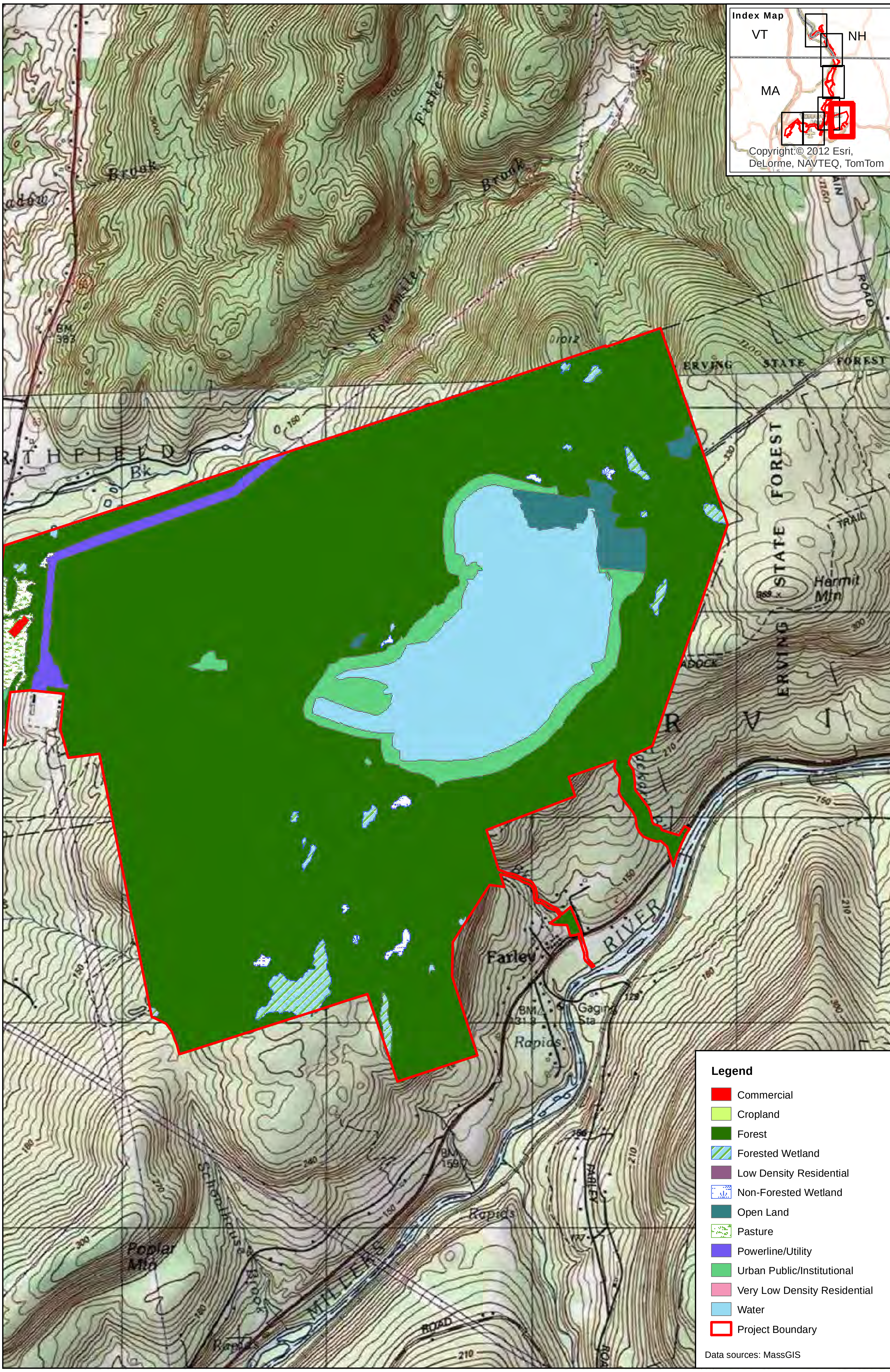

FirstLight Power Resources
GDF SUEZ

FIRSTLIGHT POWER RESOURCES
PROPOSED STUDY PLAN

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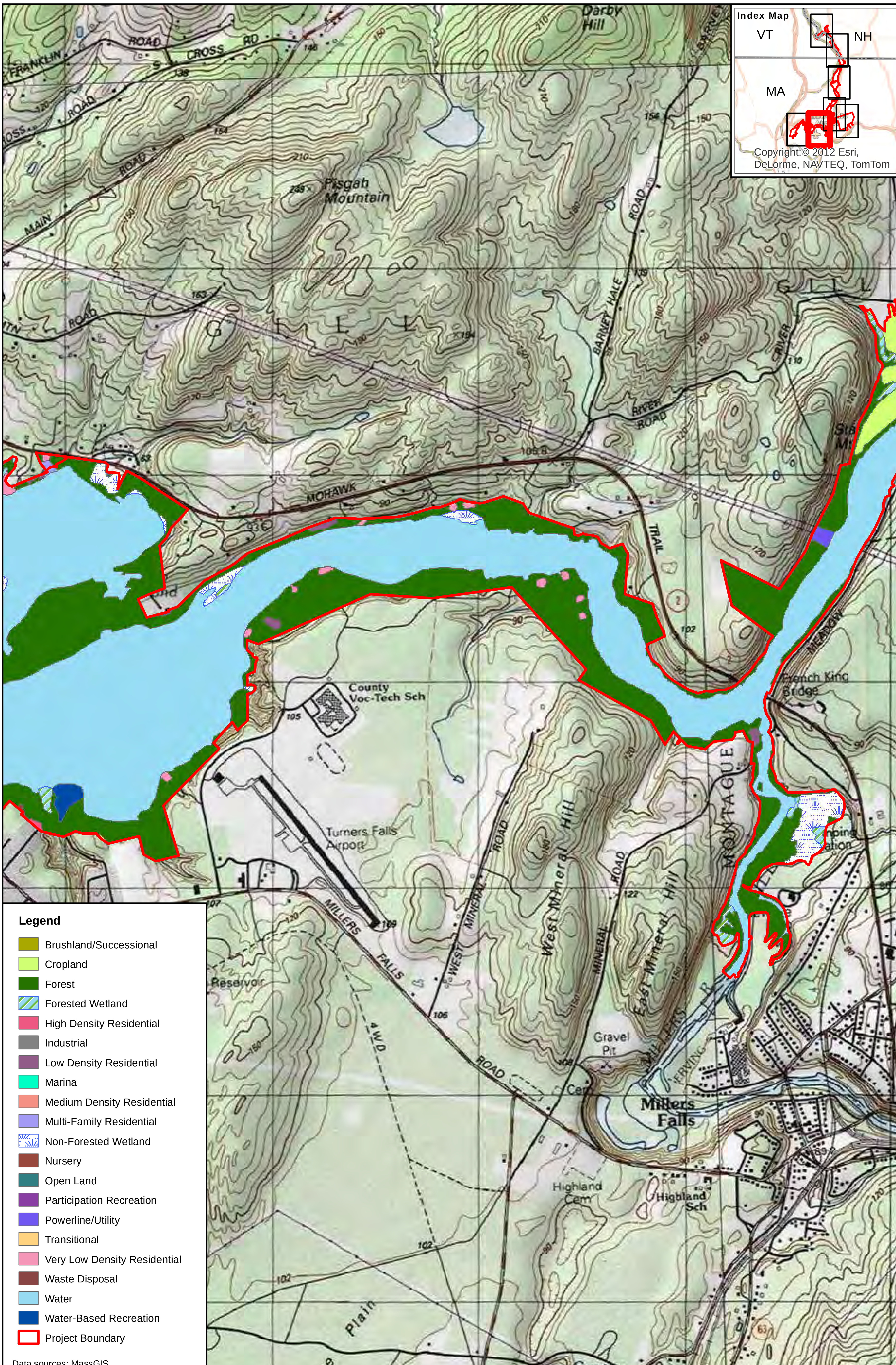
0 750 1,500 3,000 Feet

FIGURE 2.1.1 e
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 5 of 7



FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

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0 750 1,500 3,000 Feet

FIGURE 2.1.1 f
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 6 of 7

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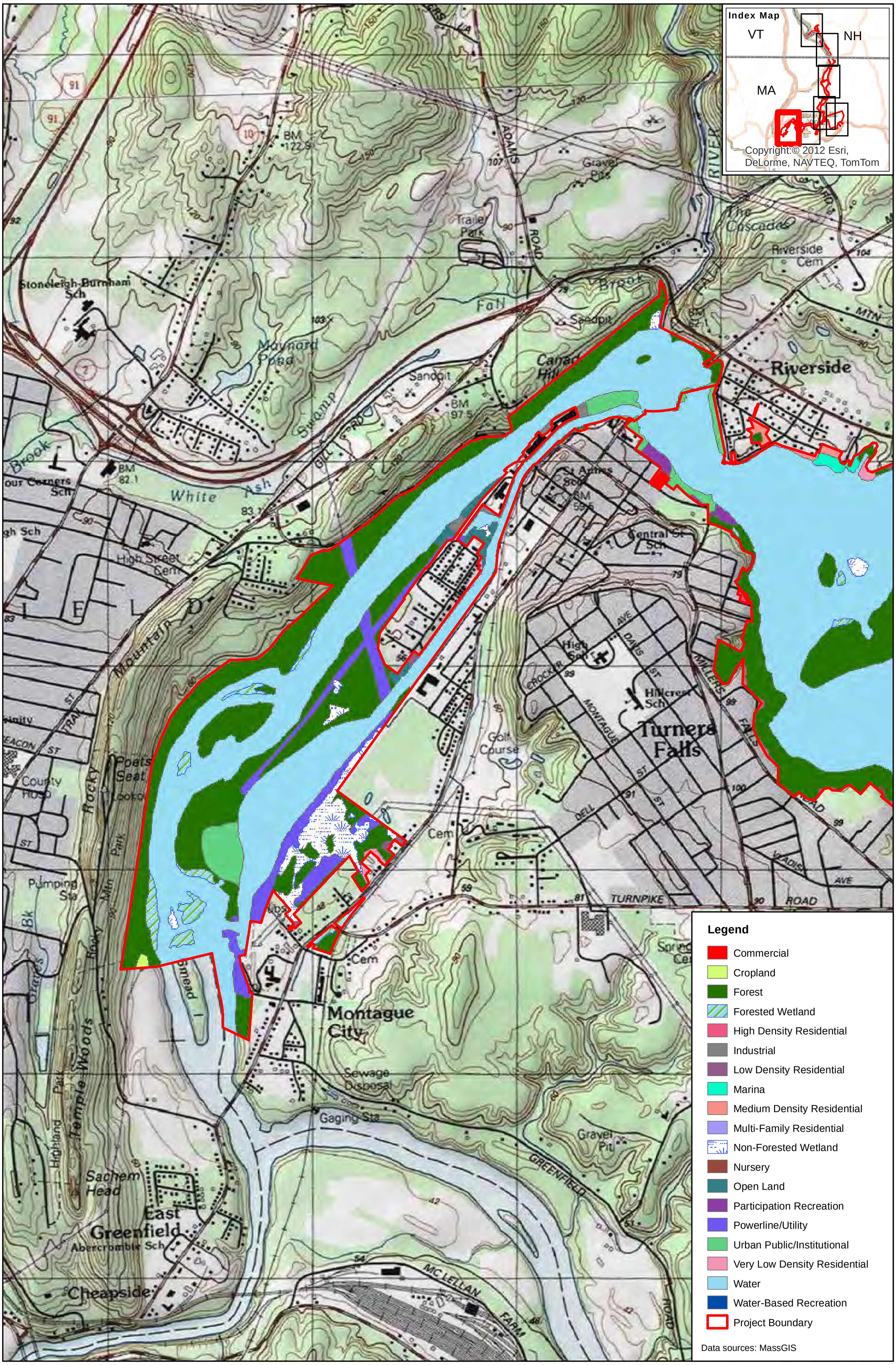

FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

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0 750 1,500 3,000 Feet

FIGURE 2.1.1 g
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 7 of 7

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Figure 2.1.5 (a-c): Photographs of Turners Falls Dam and Adjacent Facilities

Figure 2.1.5a – Turners Falls Dam, Bypass Channel, and Power Canal (looking downstream)

Figure 2.1.5b – View of Station No. 1 from Bypass Channel

Figure 2.1.5c – Upstream View of Cabot Station from Tailwater Area

2.2 Turners Falls FERC Additional Information Requests

2.2.1 Proposed Changes to Project Operation (FERC AIR #1)

FERC AIR #1: In the PAD you identify alternatives you will consider through the licensing process for potential changes to facilities and operation of the Turners Falls Project including the following: (1) upgrade Station No. 1 with new or rehabilitated turbines, (2) close Station No. 1 and add a turbine generator at Cabot of similar hydraulic capacity to Station No. 1's, and (3) use the full hydraulic capacity of Cabot Station turbines. However, you do not describe the extent or range of the possible modifications to the hydraulic capacity of Cabot Station and Station No. 1. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please provide detail on the physical and operational changes contemplated at the Turners Falls Project.

FirstLight Response: The combined hydraulic capacity of Cabot Station (13,728 cfs) and Station No. 1 (2,210 cfs) is approximately 15,938 cfs. The maximum hydraulic capacity of the power canal is approximately 18,000 cfs. In addition to Cabot Station and Station No. 1 there are other water entities having water rights to withdraw water from the canal including: Southworth Paper (115 cfs), Turners Falls Hydro, LLC (288 cfs), and a minimal amount of water used by the United States Geological Service (USGS) Conte Anadromous Fish Laboratory. Thus, any increase in hydraulic capacity would be no more than 18,000 cfs less 15,938 cfs, plus water needed for other canal users, or less than approximately 2,000 cfs. Not until studies[3] are conducted will FirstLight have a better sense of whether to propose additional hydraulic capacity, and if so, whether the additional hydraulic capacity would be located at Cabot or Station No. 1.

2.2.2 Cultural Resources (FERC AIR #2)

FERC AIR #2: In section 5.2.10 of the PAD you propose to conduct a Phase IA Archaeological Survey and Historic Structures Survey of the APE. You also indicate that FirstLight may propose to conduct a Phase IB archaeological and an intensive-level architectural level survey, depending on the results of the Phase IA investigation and after consultation with the Massachusetts, New Hampshire, and Vermont SHPOs. However, you have not provided a map specifically defining the APE, and we are unclear on how you would specifically carry out the various tasks involving your proposed study.

Include in your study proposal that you would also consult with the Vermont, Massachusetts, and New Hampshire SHPOs, and any involved Indian tribe or other interested parties in formulating each of the tasks listed below. As a result, we ask you to include the following in your study proposal for cultural resources:

a) Define an APE for the project that would include all lands enclosed by the project boundary including both in-water and on-shore project lands and facilities, and lands or properties outside the project boundary where project operations or other project-related activities may directly or indirectly cause changes in the character or use of historic properties, if any historic properties exist. Your study proposal should also include a record of consultation with the Vermont, Massachusetts, and New Hampshire SHPOs, involved Indian tribes, and other interested parties regarding the APE (Once you have defined your APE, send your APE definition and APE map to the Vermont, Massachusetts, and New Hampshire SHPOs and seek their concurrence. The APE

[3] The study that will best inform potential changes to the hydraulic capacity of the Turners Falls Project is Study No. 3.3.1 *Conduct Instream Flow Habitat Assessment in the Bypass Reach and below Cabot Station*, as described later in this document.

definition and map should be included in your study proposal, along with a record of consultation.). Include a detailed map showing all aspects of the APE, including designations of land ownership**.**

b) Include the specific techniques on how you would carry out the Phase IA investigation, in addition to any other methods (if needed) by which other cultural resources that may be directly or indirectly affected by the project will be inventoried. Your proposal should include methods for inventorying all archaeological and historic resources that may lie within the APE, including project facilities, non-project architectural resources, and properties of traditional religious or cultural significance. Attention should be given on the assessment of the Turners Falls Ceremonial Site and proposed Great Falls Native Cultural Park, and potential project-related effects to these places (see Town of Montague filing, dated February 6, 2013 and filed on February 20, 2013).

c) Develop and include in your study proposal a process for evaluating the National Register of Historic Places (National Register) eligibility of all cultural resources during the field inventory stage, and afterwards, through additional second season field investigations (If necessary: If all National Register eligibility determinations cannot be done in either the first or second season of field investigations, a program to follow-up on completing all National Register eligibility determinations of properties located within the APE could be developed and included in the Historic Properties Management Plan (HPMP).), including a strategy for examining, testing, or excavating cultural resources. This process should take into account applicable guidelines and standards promulgated by the Vermont, Massachusetts, and New Hampshire SHPOs.

d) Elaborate on what methods you would use to identify any existing project-related effects (both direct and indirect) on historic properties recorded during the field inventory, and determine how project operations may affect or potentially affect them.

e) Include in any study report: (1) a background section on previous work in and around the APE; (2) a culture history of the research area; (3) definition and map of the APE; (4) methods used for the archival research and field pedestrian survey and how the APE was systematically inventoried; (5) the results of the survey and detailed descriptions of the cultural resources found (including a table depicting type of cultural resources, age, property location, and land ownership associated artifacts, existing and potential effects, and National Register eligibility status); (6) results of National Register evaluations for all cultural resources located within the APE(In consultation with the involved parties, once you have determined which cultural resources may, or may not be eligible for the National Register, submit your evaluations to the Vermont, Massachusetts, and New Hampshire SHPOs (as applicable) for concurrence.); and (7) site or resource specific descriptions of existing and potential project-related effects on cultural resources considered to be eligible for inclusion in the National Register. Put a statement in your study proposal you will also prepare a HPMP in consultation with the involved parties and will file a draft HPMP along with your preliminary licensing proposal, and a final HPMP with your final license application (Note that once the Commission finds the HPMP to be final, we would attach it to a programmatic agreement and after noticing the Advisory Council on Historic Preservation, we would execute the programmatic agreement with the Vermont, Massachusetts, and New Hampshire SHPOs, if the Advisory Council on Historic Preservation declines to participate. Execution of the programmatic agreement would evidence that the Commission has resolved any potential adverse effects to historic properties involved with the proposed project.). Among other things, the HPMP should provide site-specific measures to resolve any potential project-related adverse effect to historic properties located within the project's APE. You should use the Guidelines for the Development of Historic Properties Management Plans for FERC

Hydroelectric Projects, developed by the Advisory Council on Historic Preservation and Commission in May 2002.

f) Provide a schedule for carrying out all of the various tasks involving your study, including the filing of draft and final reports and HPMPs.

g) Provide estimated costs associated with the various tasks in your study, along with the costs of report production and crafting the HPMP.

FirstLight Response: Sections 3.7.1 and 3.7.2 of the PSP contain FirstLight's study plans for the proposed Phase IA Archaeological Survey and Historic Structures Surveys. FERC's AIR requests that the study plans include a definition of the Area of Potential Effect (APE) and a record of consultation with the Vermont, New Hampshire, and Massachusetts SHPOs on the proposed definition of the APE. Typically, however, consultation with and concurrence of the SHPOs regarding an APE, occurs in conjunction with a SHPO's review of the cultural resources study plans so that the SHPOs will have a context in which to determine an APE. The study plans proposed herein include a proposed definition of the APE. During a study plan meeting held on June 12, 2013, the Vermont SHPO indicated that a 10-meter wide APE along waterway shorelines for archaeology has been used for hydroelectric relicensing projects in Vermont. Section 3.7.1 and 3.7.2 of this Updated PSP contain proposed APE maps for archaeology and for historic structures, respectively. The study plans also include a proposal to consult with the Vermont, New Hampshire, and Massachusetts SHPOs and the Narragansett Tribal Historic Preservation Officer (THPO) to seek their concurrence on an appropriate APE for the Projects. FirstLight will not undertake any cultural resources surveys prior to obtaining SHPO and Narragansett THPO concurrence of the definition of the APE.

FERC's AIR requests that the study plans should give attention to the assessment of the Turners Falls Ceremonial Site, the Town of Montague's proposed Great Falls Native Cultural Park and potential project-related effects to these places. The Turners Falls Ceremonial Site is located well away from the Projects. To the extent that any historic properties within the APE are identified during the course of archaeological studies undertaken in connection with the relicensing that may have a connection to the Great Falls Native Cultural Park, FirstLight will discuss these properties in its archaeological survey reports.

FERC's AIR also requests that the cultural resources study plan provide estimated costs associated with the various tasks in the study plan, along with the costs of report production and crafting the HPMP. The study plans include costs for conducting the Phase IA Archaeological Survey and Historic Structures Survey. These costs include the costs of report production. To the extent that an HPMP is necessary, FirstLight has also provided an estimate for the crafting of an HPMP. This cost will need to be refined after cultural resources surveys are complete and results are available to inform the need for and, if needed, the development of an HPMP.

2.2.3 Socioeconomic (FERC AIR #3)

FERC AIR #3: In PAD section 4.11.1., you cite a document referred to as "PVPC". However, you do not provide the complete citation. Therefore, so that we may fully understand the supporting documentation for the PAD, please provide the complete citation for the PVPC reference in PAD section 4.11.1. If this document is not readily available to the public please provide a copy of the document.

FirstLight Response: The information was obtained from the Pioneer Valley Planning Commission, and is currently available to the general public. The citation is:

Pioneer Valley Planning Commission (PVPC). (n.d). Profile of the Region – The Pioneer Valley. Retrieved from http://www.pvpc.org/about/profileofregion.shtml on 3/13/2013.

2.2.4 Recreation and Land Use (FERC AIR #4)

FERC AIR #4: In the PAD, the current project boundary maps are presented. However, it is difficult to discern ownership and extent of shoreline buffer from the maps and associated narrative in the PAD. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please describe the project boundary (i.e., is it a metes and bounds survey, and elevation contour, or some combination), and shoreline buffer (e.g., typical distance from normal reservoir elevation to the project boundary, vegetative cover types).

In the PAD, there is no information on the recreation facilities and public access and use on the unnamed island located to the west of the power canal and east of the bypassed reach of the Connecticut River. The PAD also lacks information regarding how access to the island may be restricted by project uses. During the scoping meetings, we learned that the island is accessible by two walkway bridges which are currently closed. Therefore, please provide information on the ownership and management of the walkway, bridges, and an explanation of why the bridges are closed.

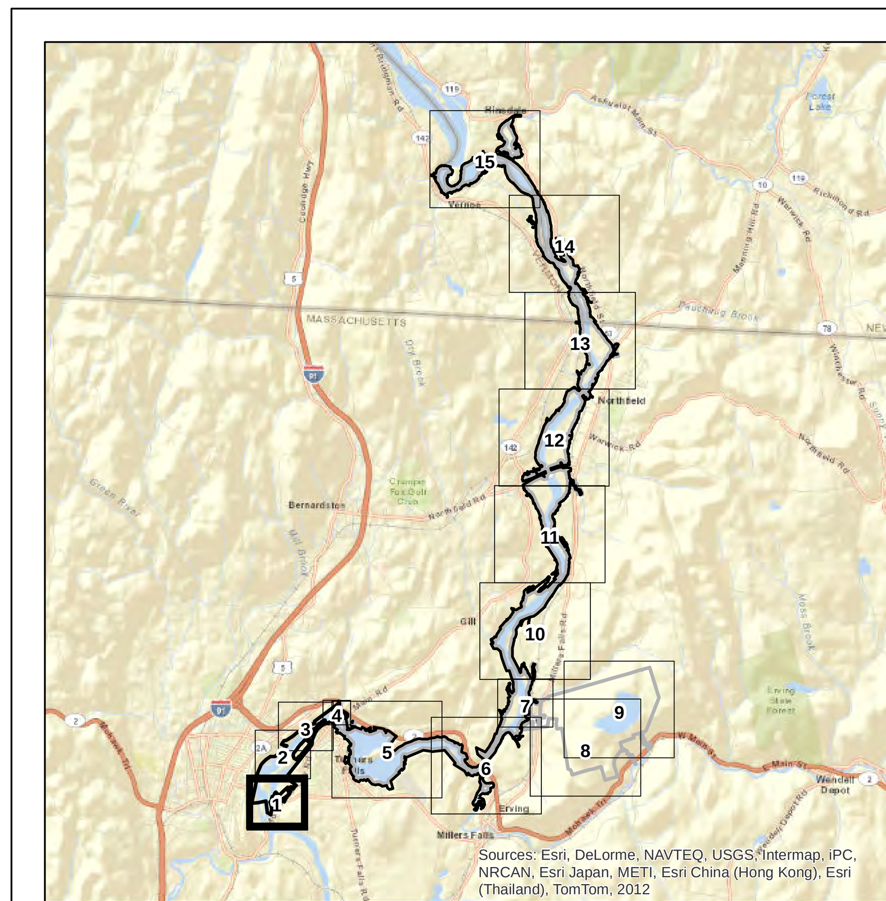
FirstLight Response: Detailed aerial maps of the Turners Falls and Northfield Projects showing the Projects' boundaries by metes and bounds survey and/or contour elevations, shoreline buffers, and location of recreational facilities associated with the Projects are contained in Figures 2.2.4-1 to 2.2.4-15.

The first walkway bridge is the Strathmore Footbridge. In an 1873 indenture between Turners Falls Company (TFC), predecessor to the Licensee, and Keith Paper Company (KPC), predecessor to the Town of Montague in which TFC conveyed land to KPC, TFC agreed to "*forever maintain a suitable bridge over said canal*." After the canal was lengthened and widened in the early 1900's, TFC and KPC reached a new agreement, which was recorded in a 1912 indenture. In this indenture was a lease that allowed TFC and its successors, for a period of 99 years, to maintain and operate a drain or tunnel (Keith drainage pipe) across KPC's land from the canal to the westerly edge of the Connecticut River. In consideration of this, TFC agreed to construct and maintain a steel footbridge from Canal Street to the mill for the purpose of traveling to the mill and carrying "*property, goods and merchandise*." The mill side of the bridge ends in the mill's second floor. The obligation to maintain the footbridge lasted the duration of the lease. Paper production at the mill stopped in 1994 when the then current mill owner (International Paper) shut down operations. The lease expired March 31, 2011 and the Strathmore footbridge was closed. FirstLight retains title to the footbridge. The Strathmore Bridge has never been used or needed for project purposes.

The second bridge is known as the IP Bridge. The IP Bridge resides just downstream of FirstLight's canal headgate house for the power canal. This bridge was present before the canal enlargement and was also modified. Another International Paper Company mill was located on the island near the headgate house, and this bridge was used for mill access. Unlike the Strathmore footbridge, the IP Bridge was built for vehicular use. The bridge is currently posted for a weight limit of 20 ton (2 axle truck) and 30 ton (3 axle truck) with a posted speed limit of 10 miles per hour. The bridge is gated to restrict vehicular access although it is available for emergency use up to the ratings posted. In addition, FirstLight allows pedestrian access across the bridge for recreation purposes, such as fishing access. FirstLight retains title to the IP Bridge.

The State of Massachusetts owns and maintains three other bridges that provide access to the island. The Fifth Street Bridge provides for vehicular access to the industrial end of the island from the Town of Montague for mill access and deliveries. The Sixth Street bridge, located just downstream of the Fifth Street bridge and the Eleventh Street bridge located just downstream of the Sixth Street bridge, are used to access a residential area on the island, the USGS Conte Research Laboratory, the Turners Falls Project No. 1 Station, Branch Canal, Cabot Woods recreation areas, and the back gate of Cabot Station.

The locations of the five bridges are depicted on Figure 2.2.4 -3 and Figure 2.2.4-4.



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-1

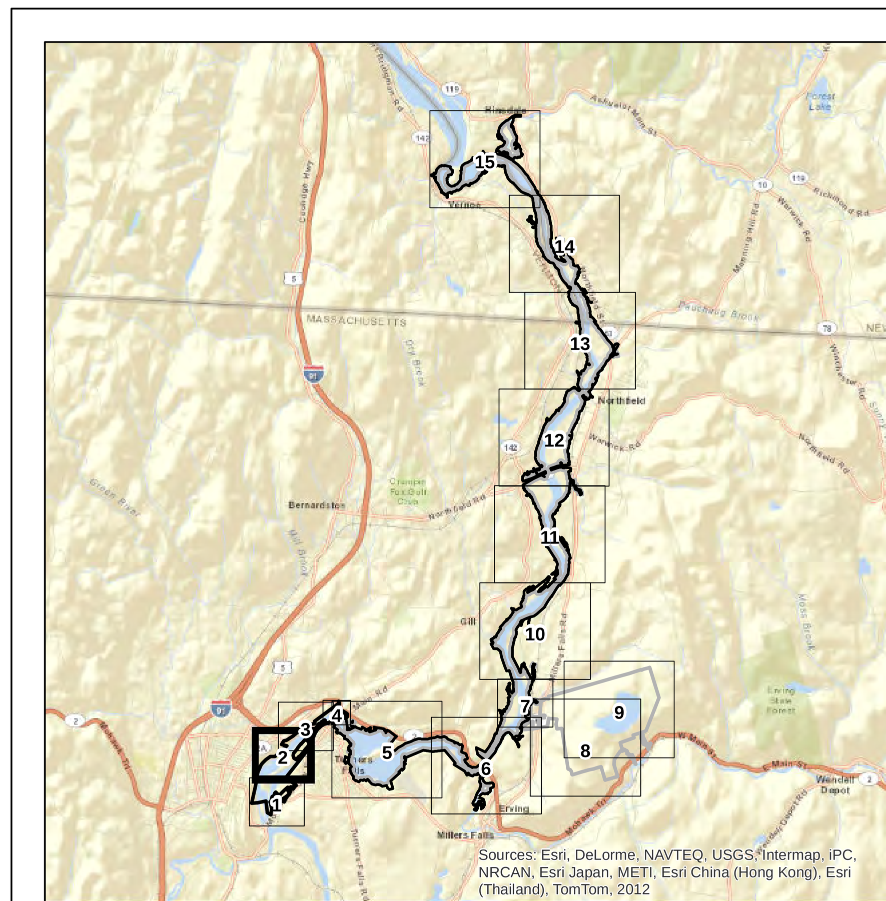
SHEET 1 OF 15

200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400



Legend

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NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-2

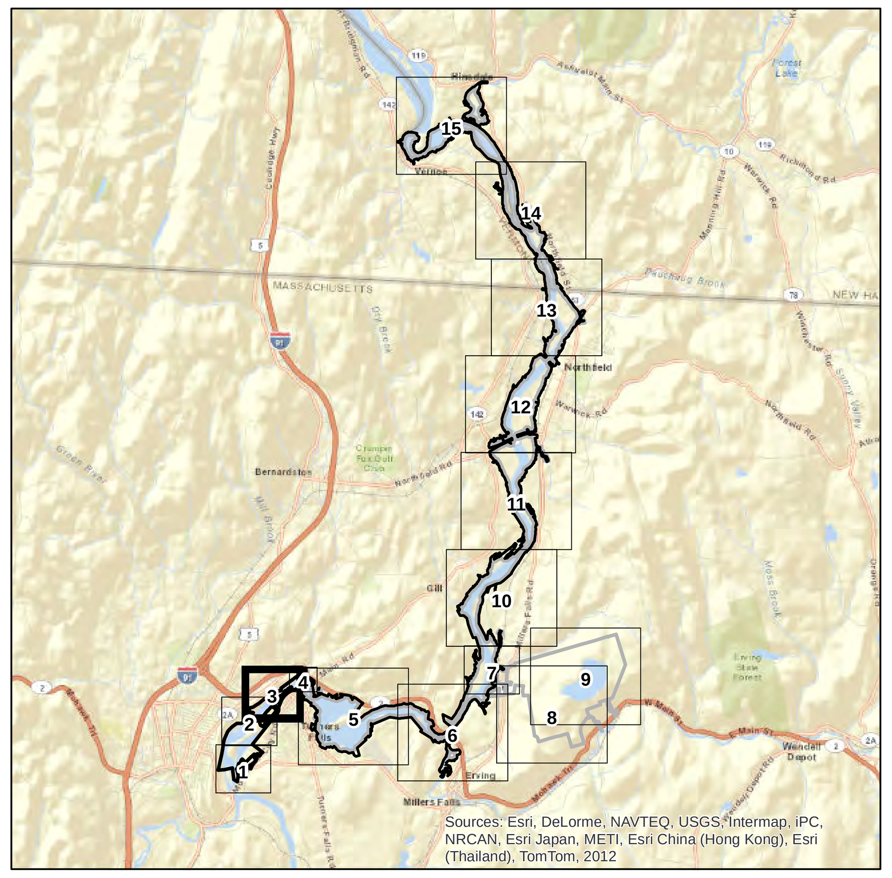
SHEET 2 OF 15

200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT Project Boundary Elevation Contour

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-3

SHEET 3 OF 15

200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400

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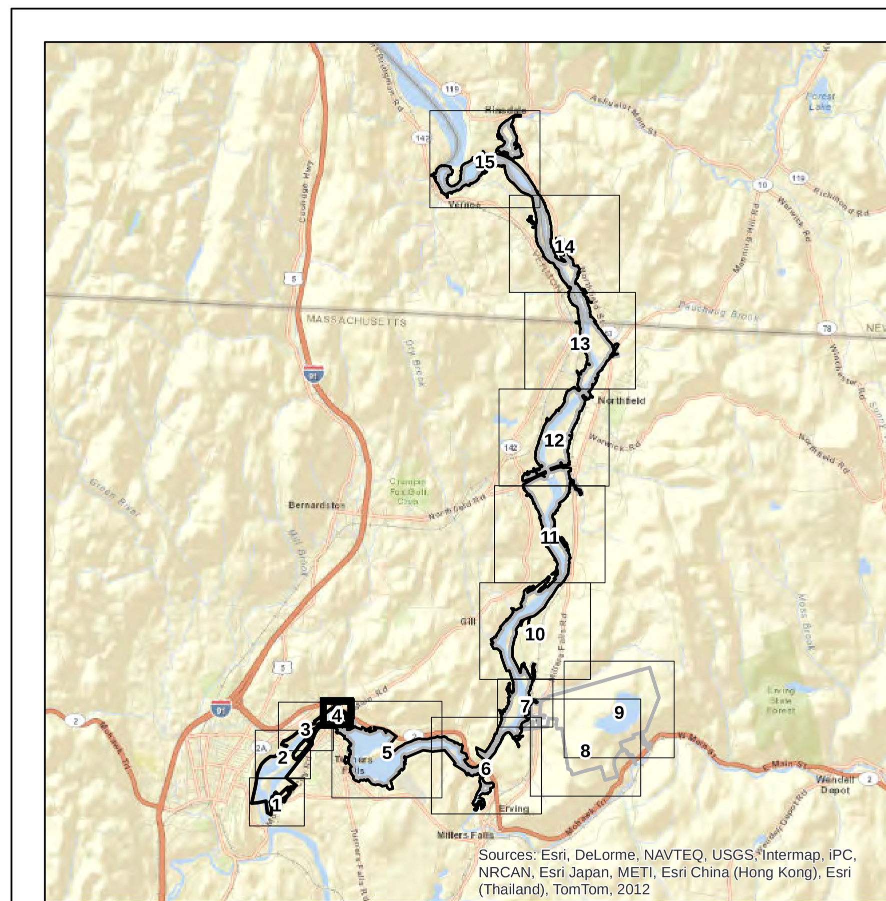

Legend

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-4

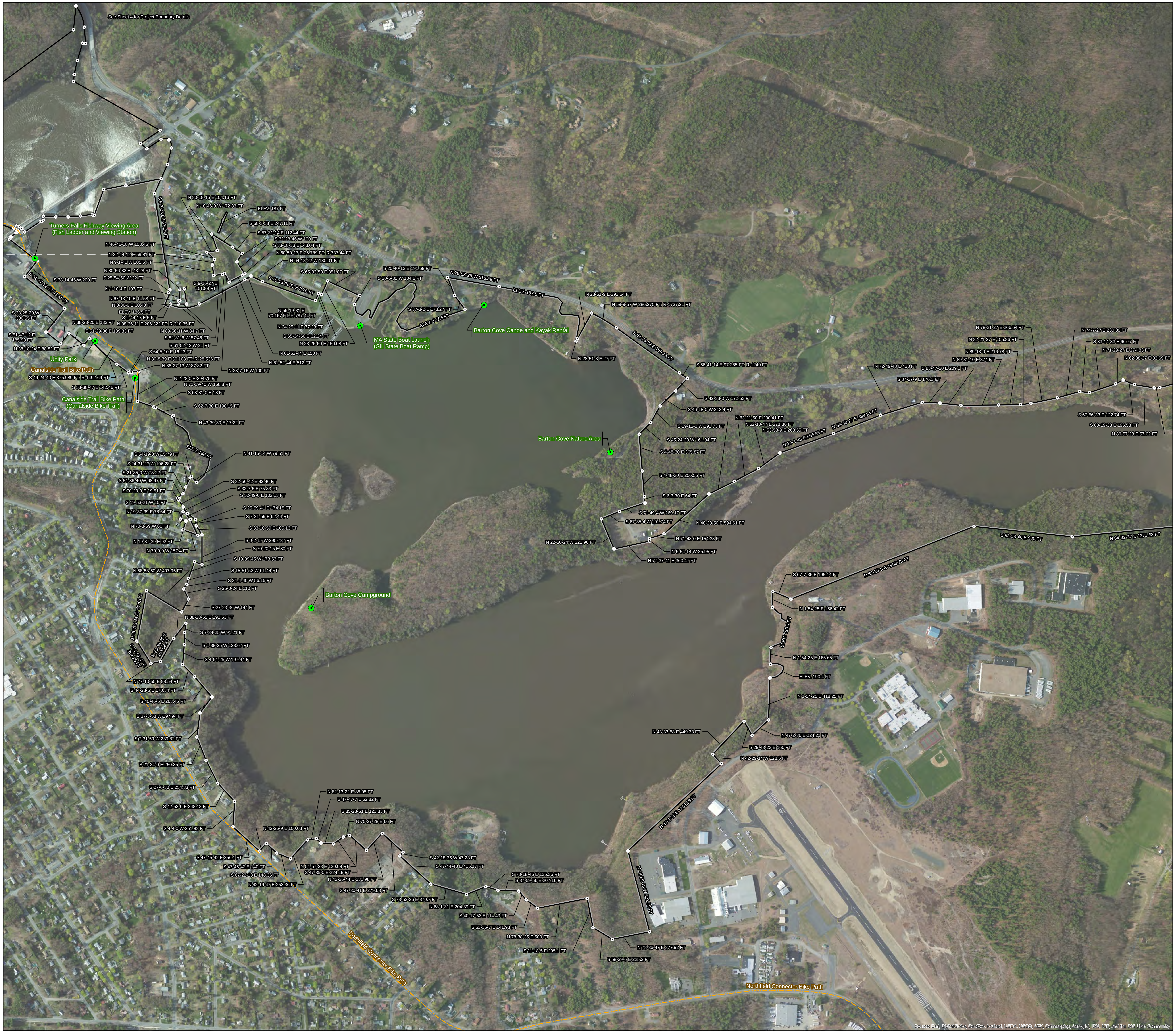
SHEET 4 OF 15

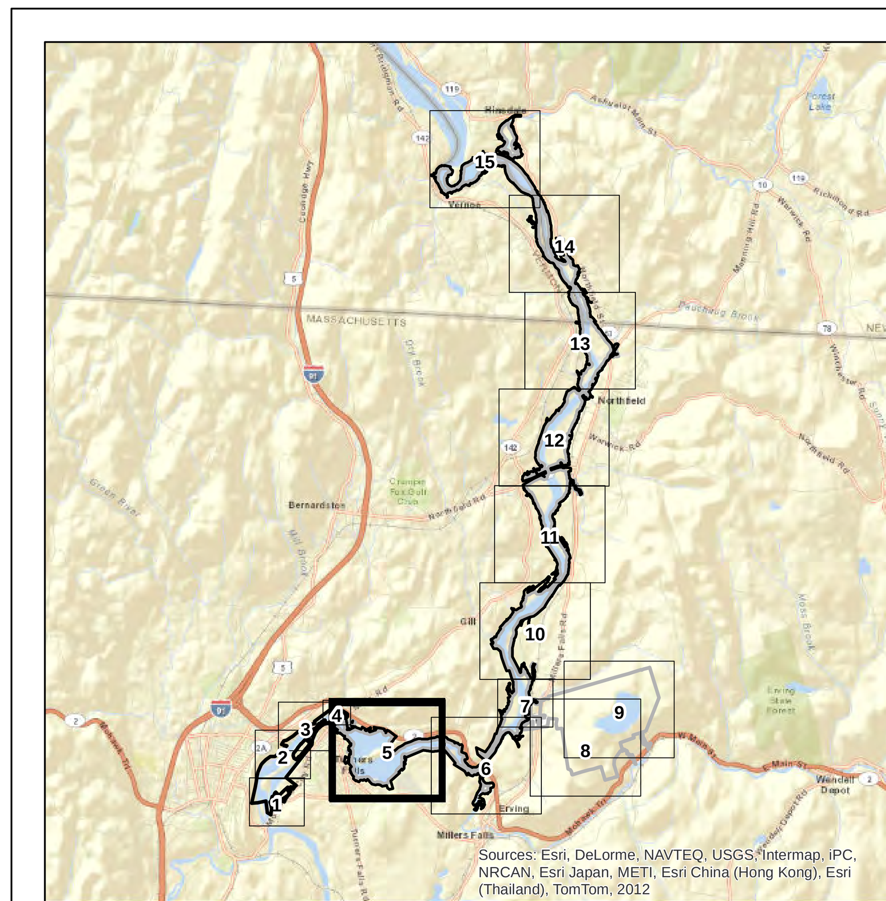
100 50 0 100 200 300 400 Feet

1 inch = 100 feet

When printed full size (28"X40")

1:1,200





Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-5

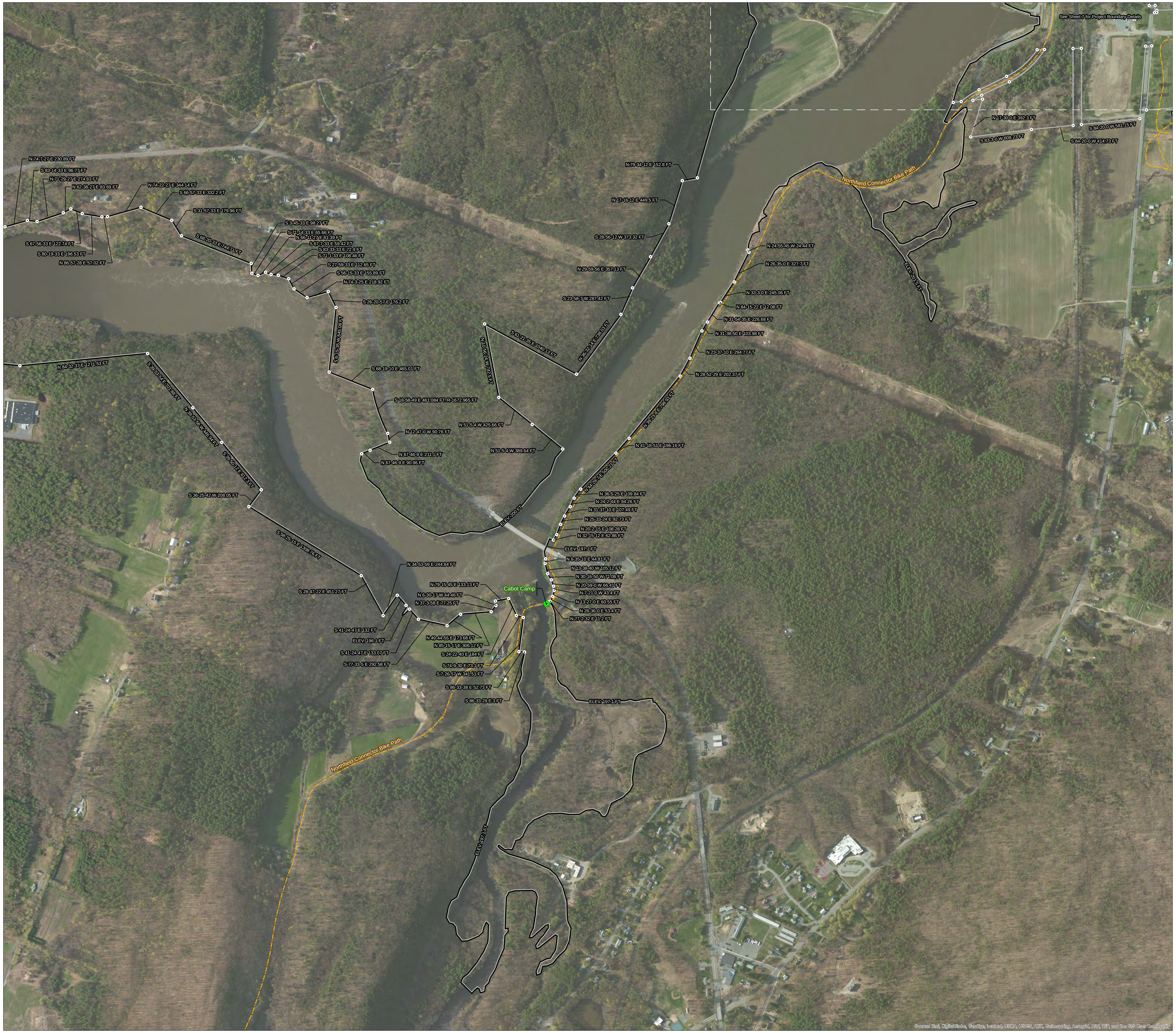
SHEET 5 OF 15

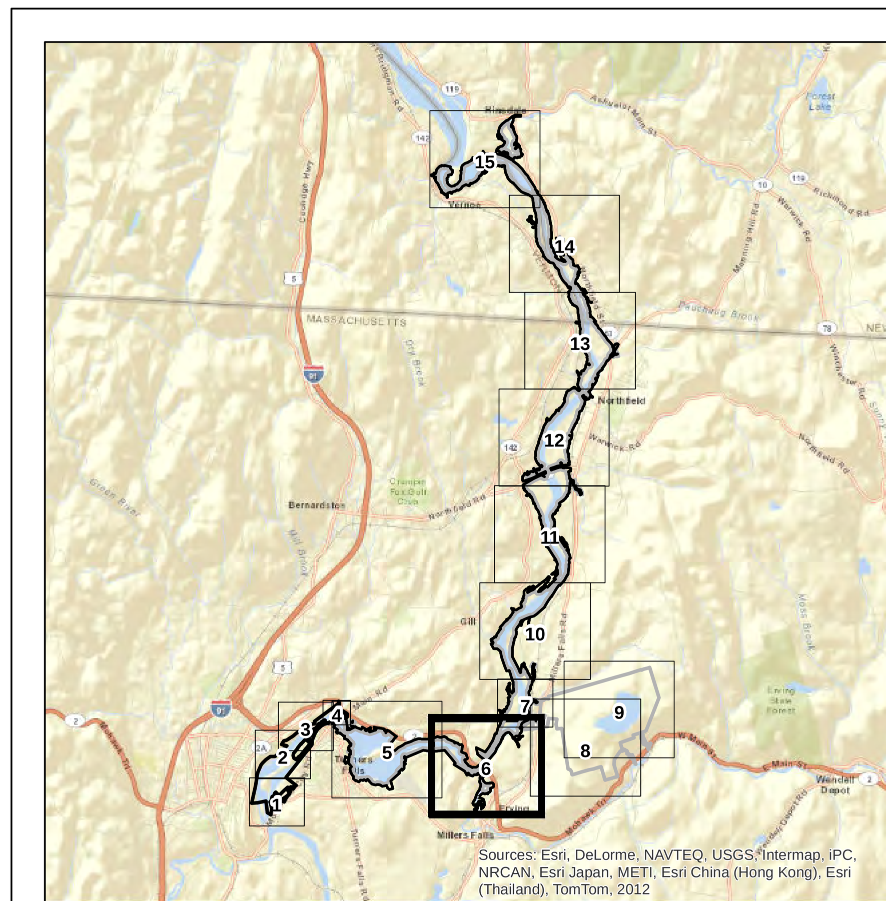
400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800





Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT — Project Boundary Elevation Contour

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NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-6

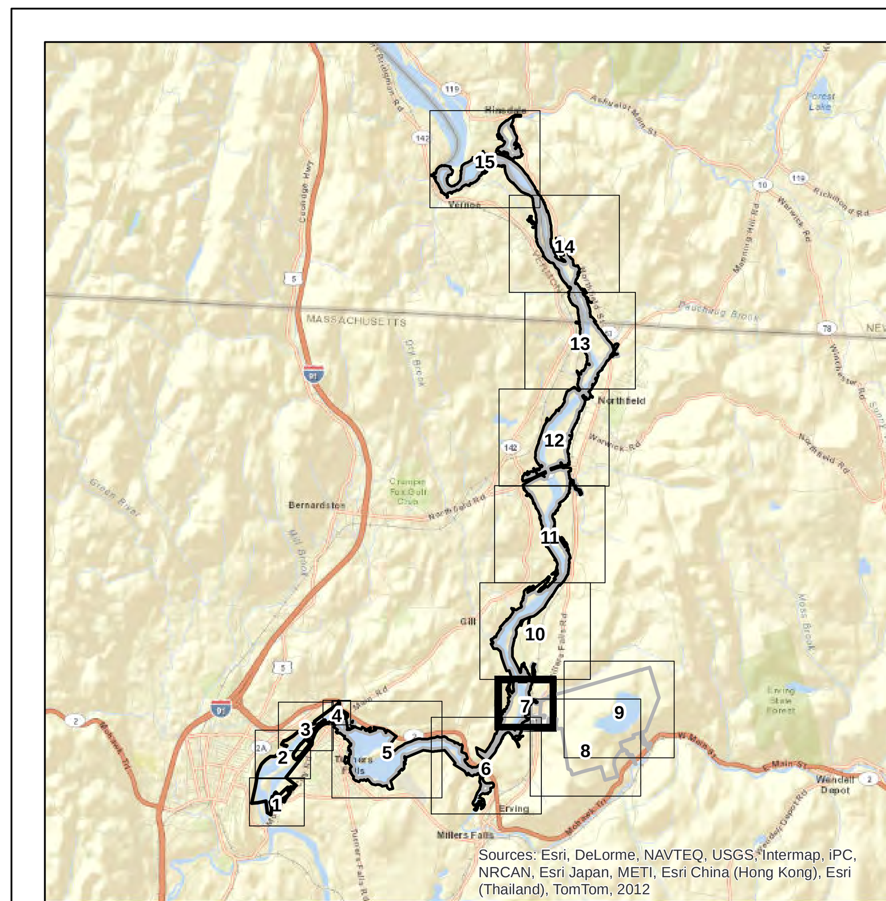
SHEET 6 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-7

SHEET 7 OF 15

200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400

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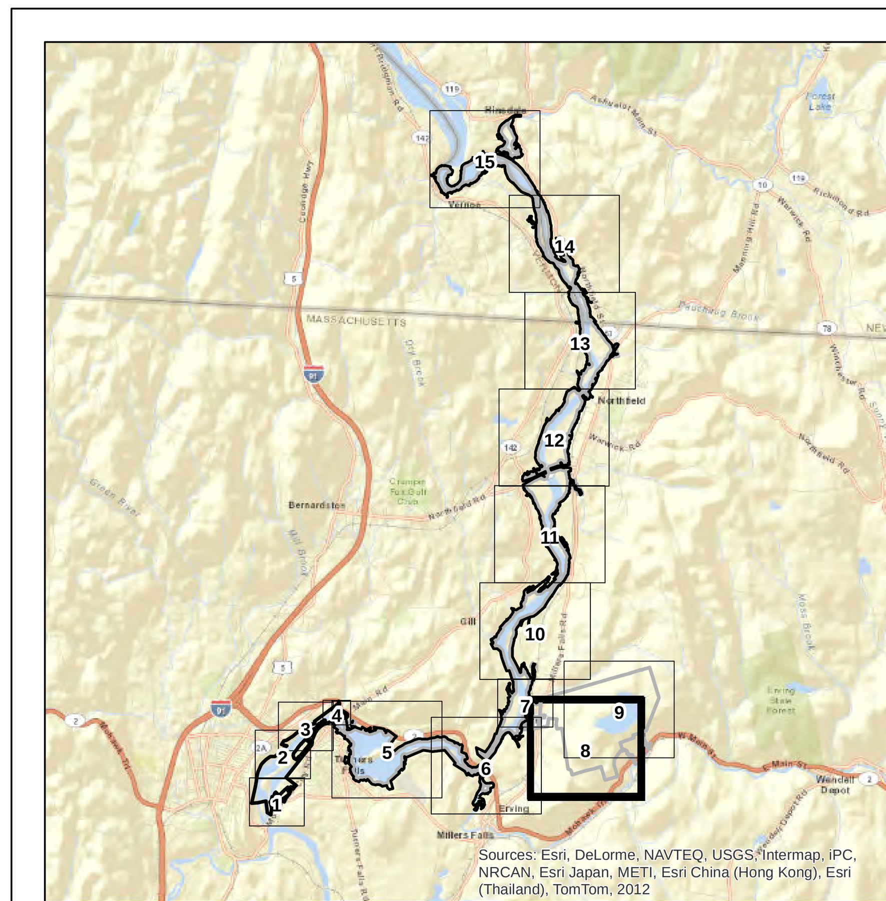

Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.8 FT — Project Boundary Elevation Contour

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-8

SHEET 8 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

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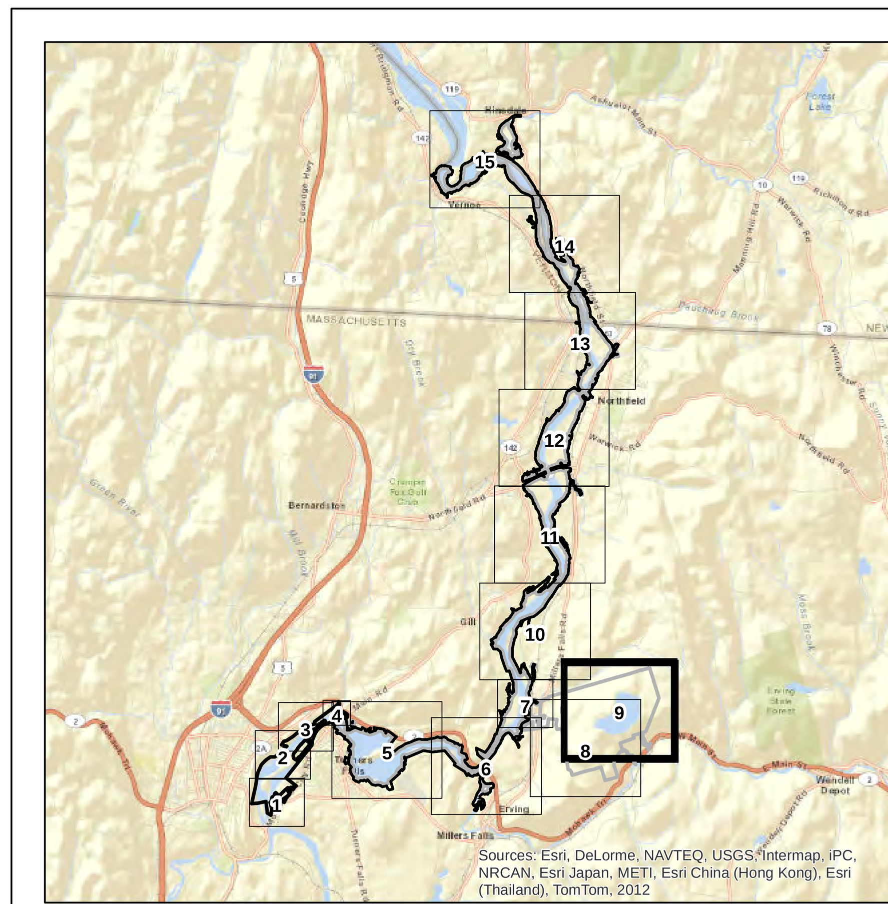

Legend

- Recreation Facility
- Project Trail
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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-9

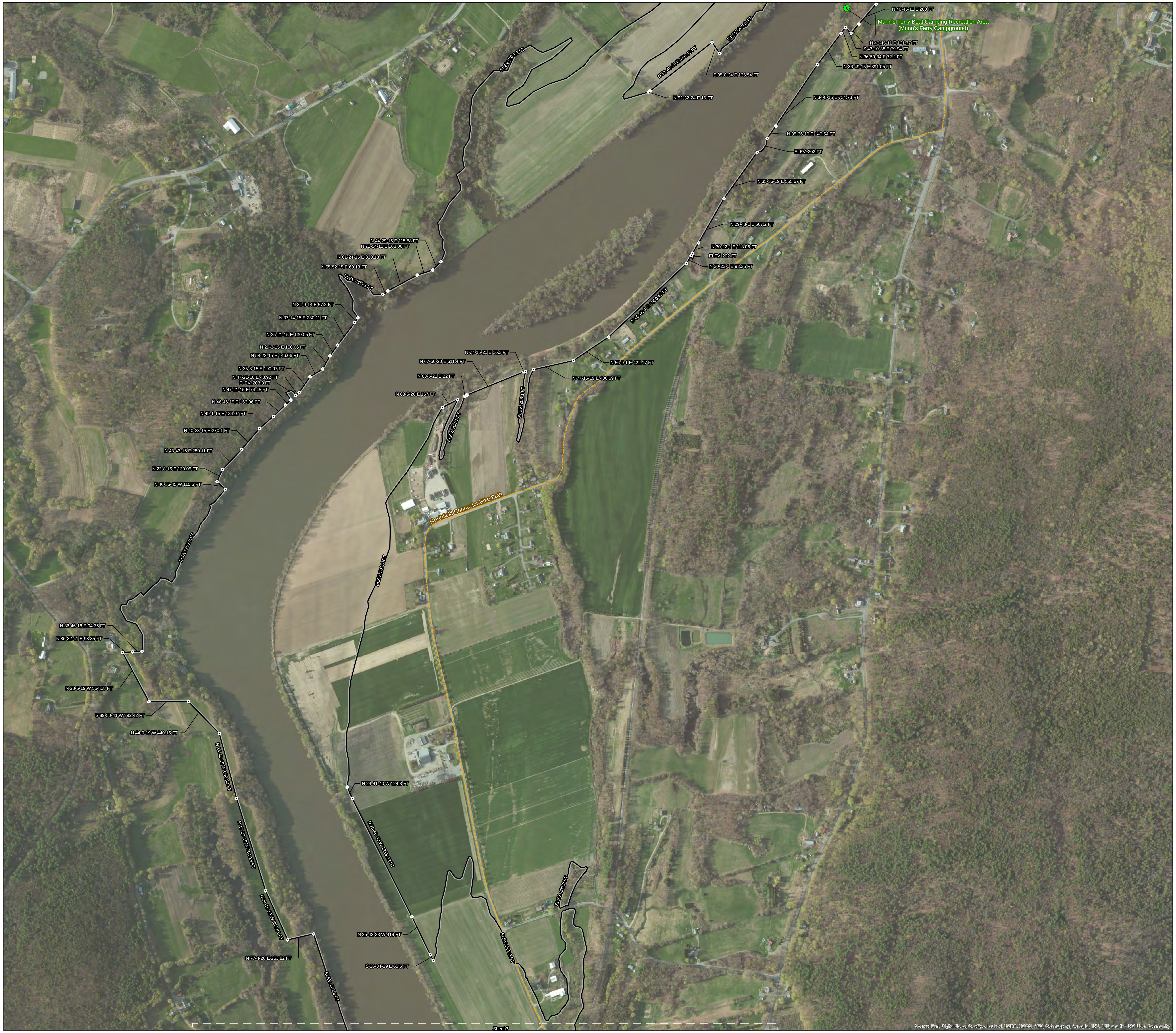
SHEET 9 OF 15

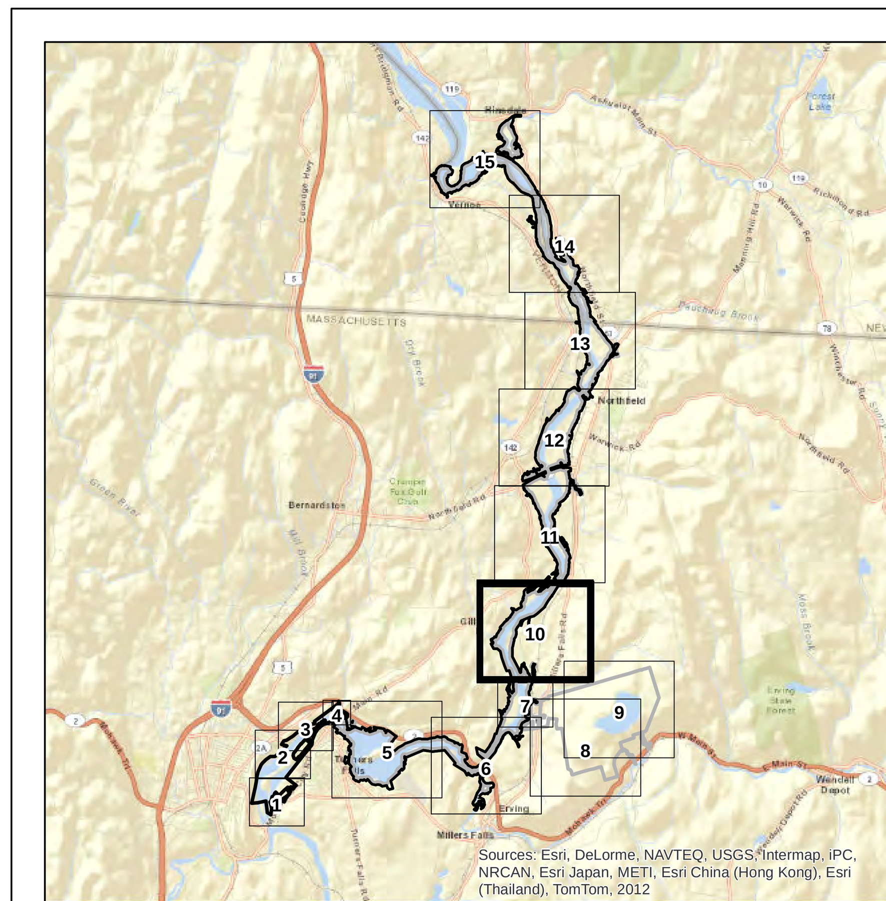
400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800





Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-34-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-10

SHEET 10 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

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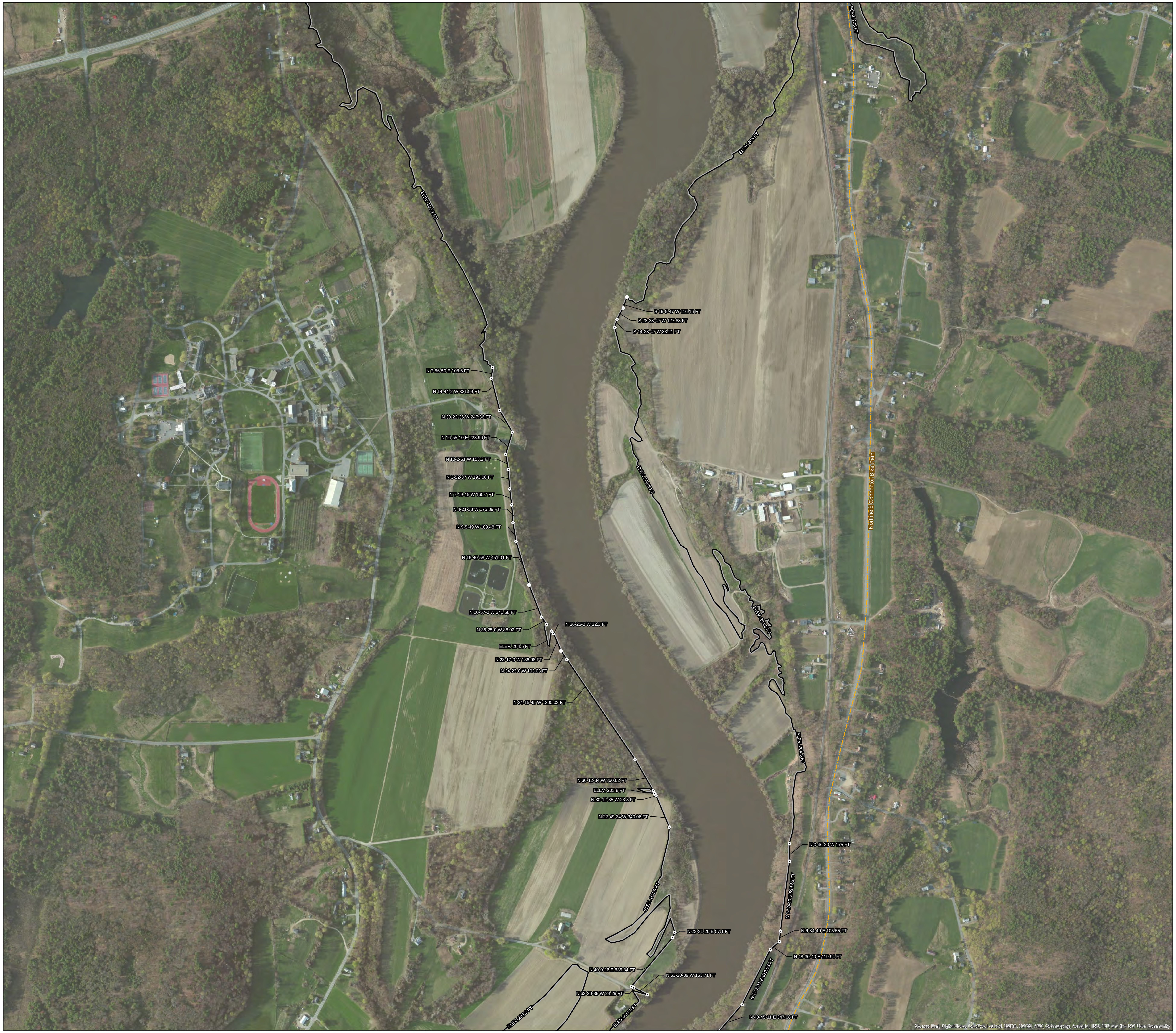

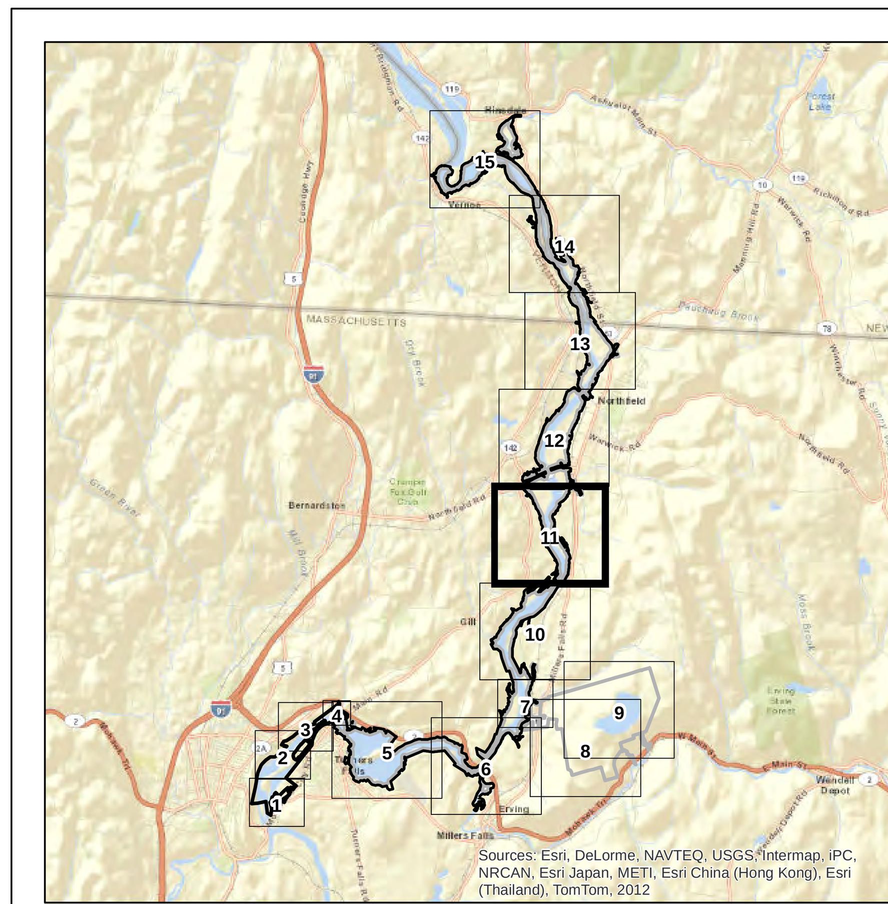

Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-11

SHEET 11 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800

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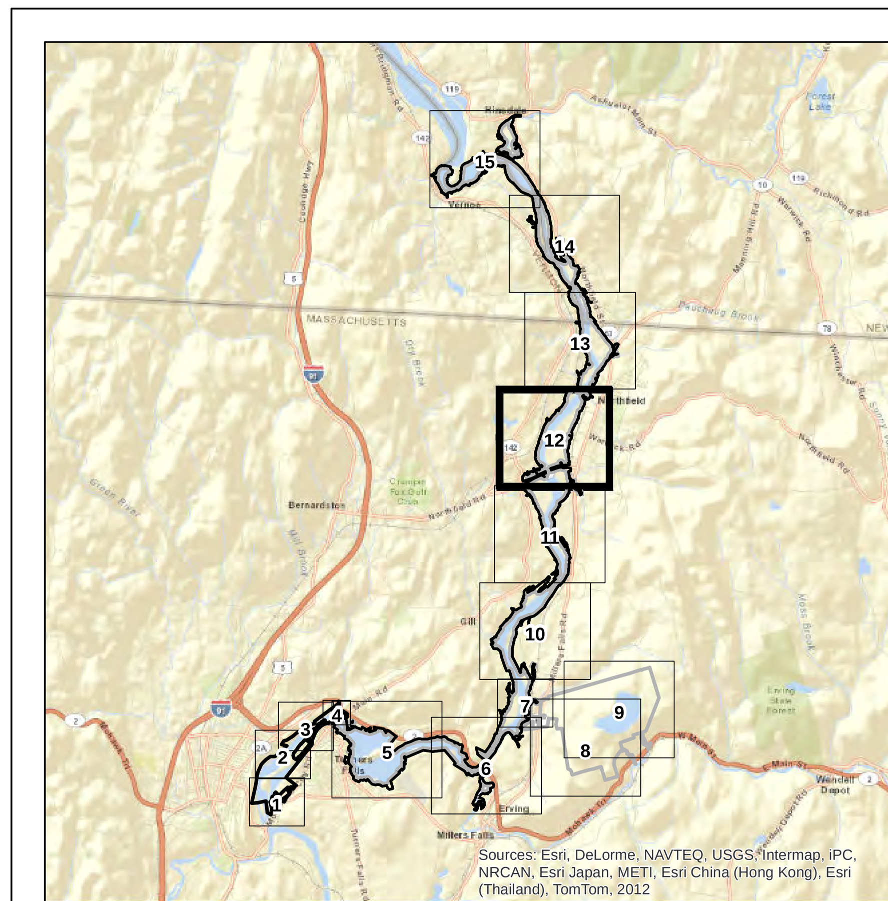

Legend

- Recreation Facility
- Project Trail
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- Turners Falls Hydroelectric Project Boundary
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N

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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-12

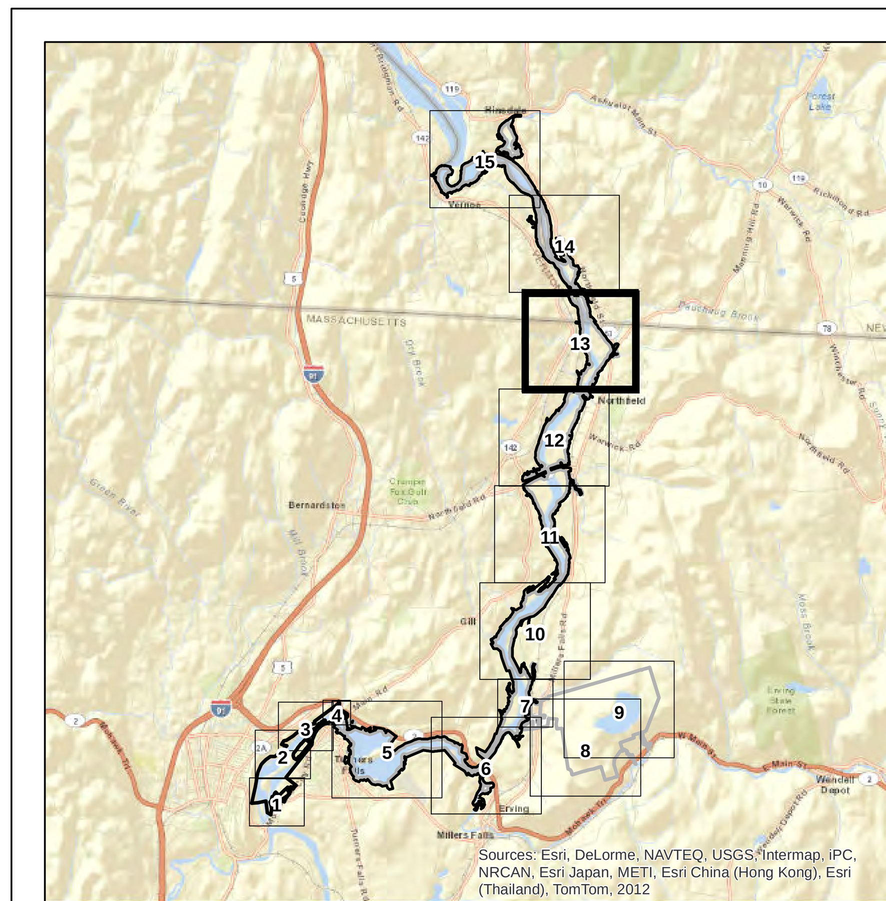
SHEET 12 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
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PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-13

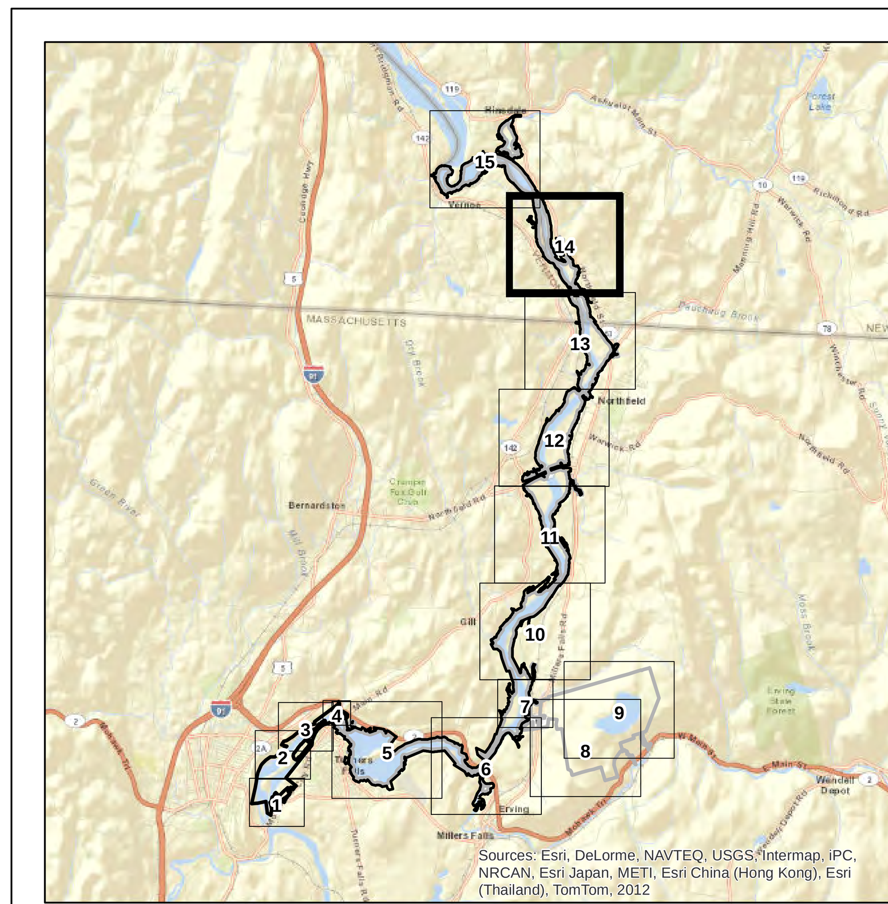
SHEET 13 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT — Project Boundary Elevation Contour

N

FirstLight Power Resources

GDF SUEZ

FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-14

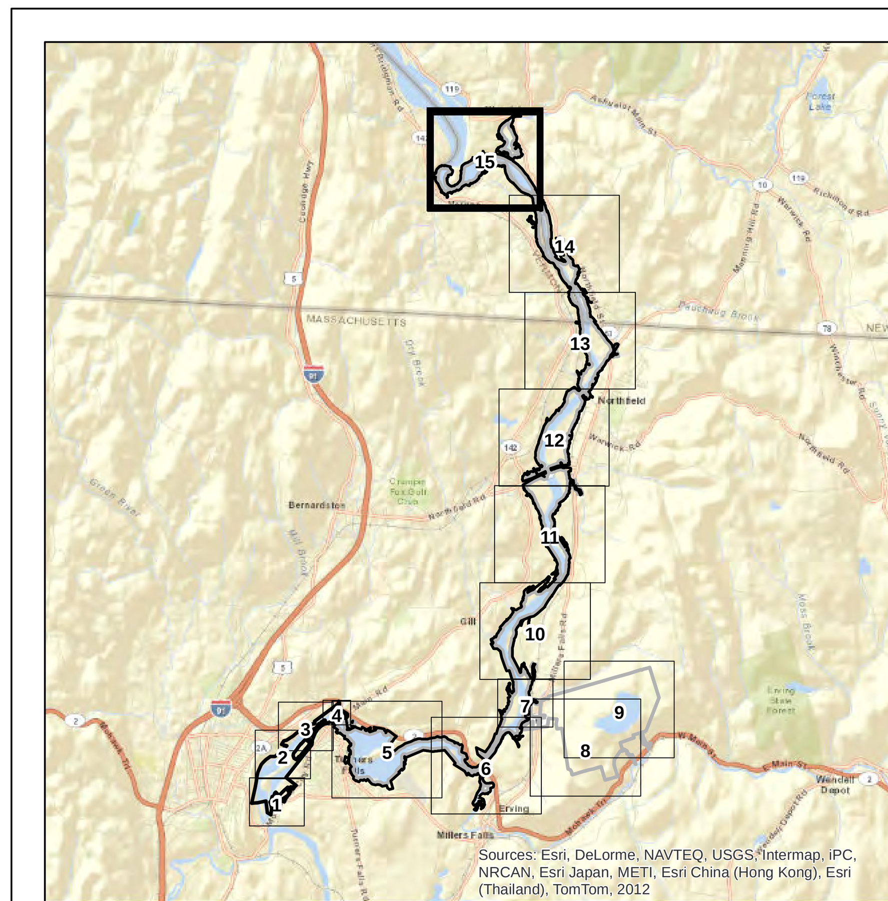
SHEET 14 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT — Project Boundary Elevation Contour

N

FirstLight Power Resources

GDF SUEZ

FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-15

SHEET 15 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800

2.3 Northfield Mountain Pumped Storage Project FERC Additional Information Requests

2.3.1 Proposed Changes to Project Operation (FERC AIR #5)

FERC AIR #5: In the PAD you propose potential changes to facilities and operation of the project including the following: (1) utilize more storage in the Northfield Mountain Project's upper reservoir and, (2) increase the unit and station capacity. However, you do not describe the extent of possible modifications to the hydraulic capacity and to the storage operations within the upper reservoir. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please provide detail on the physical and operational changes contemplated at the Northfield Mountain Pumped Storage Project.

FirstLight Response: Relative to the Northfield Mountain Project, the maximum additional increase in hydraulic capacity when operating in a generation mode would be approximately 2,000 cfs, or 500 cfs/turbine for potential total station hydraulic capacity of approximately 22,000 cfs (compared to 20,000 cfs currently). Based on preliminary analysis, under a maximum hydraulic capacity of approximately 22,000 cfs, the station capacity would increase from the 1,168 MW to approximately 1,174 MW.

Relative to storage operations, the upper reservoir is licensed to fluctuate between 1000.5 feet msl and 938 feet msl, a total fluctuation of 62.5 feet. As noted in the PAD, the upper reservoir was originally designed to safely retain water up to elevation 1004.5 feet, msl and can be drawn down to elevation 920 feet, msl. The increase in fluctuation provides for an additional 3,009 acre-feet of storage and 1,990 MWHs of energy. FirstLight will be conducting further analysis to determine the feasibility of utilizing more upper reservoir storage capacity.

2.3.2 Recreation and Land Use (FERC AIR #6)

FERC AIR #6: In the PAD, the project boundary maps are presented. However, it is difficult to discern ownership and extent of shoreline buffer from the maps and associated narrative in the PAD. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please describe the project boundary (i.e., is it a metes and bounds survey, and elevation contour, or some combination), and shoreline buffer (e.g., typical distance from normal reservoir elevation to the project boundary, vegetative cover types).

FirstLight Response: Detailed aerial maps of the Turners Falls and Northfield Projects showing the Projects' boundaries by metes and bounds survey and/or contour elevations, shoreline buffers, and location of recreational facilities associated with the Projects are contained in Figures 2.2.4-1 to 2.2.4-15.

2.3.3 Cultural Resources (FERC AIR #7)

FERC AIR #7: In section 4.10.4 of the PAD, you state that, by letter dated September 30, 2011, the Massachusetts SHPO has recommended that a qualified cultural resources consultant research and compile the information necessary to identify historic and archaeological resources and archaeologically sensitive areas within the project's APE. In section 5.2.10 of the PAD you propose to conduct a Phase IA Archaeological Survey and Historic Structures Survey of the APE. You also indicate that FirstLight may propose to conduct a Phase IB archaeological and an intensive-level architectural level survey, depending on the results of the Phase IA investigation and after consultation with the Massachusetts, New Hampshire, and Vermont SHPOs. However, you have not provided a map specifically defining the APE, and we are unclear on how you would specifically carry out the various tasks involving your proposed study. As a result, in your study proposal for cultural resources we ask you to include the same information, specific to the Northfield Mountain Project, as outlined above for the Turners Falls Project. Include in your study proposal that you would also consult with the Vermont, Massachusetts, and New Hampshire SHPOs, and any involved Indian tribe or other interested parties in formulating each of the tasks.

FirstLight Response: Sections 3.7.1 and 3.7.2 of the Proposed Study Plan contain FirstLight's study plans for the proposed Phase IA Archaeological Survey and Historic Structures Surveys. FERC's AIR requests that the study plans include a definition of the APE and a record of consultation with the Vermont, New Hampshire, and Massachusetts SHPOs on the proposed definition of the APE. Typically, however, consultation with and concurrence of the SHPOs regarding an APE, occurs in conjunction with a SHPO's review of the proposed study plans so that the SHPOs will have a context in which to determine an APE. The study plans proposed herein include a proposed definition of the APE. The study plans also include a proposal to consult with the Vermont, New Hampshire, and Massachusetts SHPOs to seek their concurrence on an appropriate APE for the Projects. FirstLight will not undertake any cultural resources surveys prior to obtaining SHPO concurrence of the definition of the APE.

FERC's AIR requests that the study plans should give attention to the assessment of the Turners Falls Ceremonial Site and the Town of Montague's proposed Great Falls Native Cultural Park and potential project-related effects to these places. The Turners Falls Ceremonial Site is located well away from the Projects. To the extent that any historic properties within the APE are identified during the course of archaeological studies undertaken in connection with the relicensing that may have a connection to the Great Falls Native Cultural Park, FirstLight will discuss these properties in its archaeological survey reports.

FERC's AIR also requests study plans provide estimated costs associated with the various tasks in the study plan, along with the costs of report production and crafting the HPMP. The study plans include costs for conducting the Phase IA Archaeological Survey and Historic Structures Survey. These costs include the costs of report production. To the extent that an HPMP is necessary, FirstLight has also provided an estimate for the crafting of an HPMP. This cost will need to be refined after cultural resources surveys are complete and results are available to inform the need for and, if needed, the development of an HPMP.

3.0 PROPOSED STUDIES

3.1 Geology and Soils

3.1.1 2013 Full River Reconnaissance Study

General Description of Proposed Study

FirstLight is required by FERC to conduct a Full River Reconnaissance (FRR) Study every 3-5 years in accordance with the Northfield Mountain Project's Erosion Control Plan (ECP) and to satisfy compliance requirements associated with the Turners Falls Project and Northfield Mountain Project licenses. The next FRR is slated for November 2013 during leaf off conditions. With the impending relicensing effort and timing of the next FRR, FERC contacted FirstLight and indicated that the 2013 FRR should be folded into the relicensing.

Prior to FERC contacting FirstLight, FirstLight had been working with the Franklin Regional Council of Government (FRCOG), Connecticut River Watershed Council (CRWC), and Landowners and Concerned Citizens for License Compliance (LCCLC) on crafting a Quality Assurance Project Plan (QAPP). The goal of the QAPP is to ensure consistency with data collection methods such that any future FRRs would allow for direct comparison. A draft version of the QAPP and FRR was circulated to the FRCOG, CRWC and LCCLC for review and comment, and a meeting was held. Since the QAPP/FRR is now incorporated into the FERC relicensing process, FirstLight developed this study plan based on FERCs study plan criteria. However, as part of this study, stakeholders should also review Appendix D, which includes the QAPP for the FRR. **[NOTE: the revised QAPP is not included in this Updated Proposed Study Plan, but will be included in the Revised Study Plan]** This work plan reflects comments received from the Massachusetts Department of Environmental Protection (MADEP) during a meeting on March 26, 2013, and comments received from stakeholders during Study Plan meetings on May 15, 2013 and June 14, 2013.

Several stakeholder groups submitted requests for a study of shoreline erosion caused by Northfield Mountain Pumped Storage operations. These study requests were received from: MADEP, New Hampshire Fish and Game Department (NHFGD), New Hampshire Department of Environmental Service (NHDES), FRCOG, Franklin Conservation District (FCD), CRWC, LCCLC and the Town of Gill. Portions of these study requests were incorporated into this study, while other portions are discussed in Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability.*

The proposed FRR study calls for conducting a boat and land-based survey along the riverbanks of the Turners Falls Impoundment to document erosion using consistent methods and procedures to allow for comparisons of any future FRRs. It was not designed to determine the cause of erosion; that issue is addressed in Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability.*

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The purpose of the FRR study, together with its QAPP (Appendix D), is to conduct a reconnaissance level evaluation and mapping of erosion in the Turners Falls Impoundment without reference to the cause of erosion. The goals and objectives of this study are to:

- Document existing riverbank features and characteristics;

- Accurately map and scientifically describe all portions of the Turners Falls Impoundment where active or recent bank erosion is occurring;
- Spatially define, using a global positioning system (GPS), the transition points or end points where riverbank characteristics or features change from one classification to another;
- Map land use practices with 200 feet of the riverbank and islands from Turners Falls Dam to Vernon Dam.
- Walk the riverbanks and islands from Turners Falls Dam to Vernon Dam to document existing erosion and potential bank instability[4].
- Develop classification techniques of observations into a definable and repeatable methodology;
- Develop distribution and summary statistics of conditions in 2013, assess change in riverbank conditions in context of the "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River (ECP)*" (1999) since implementation, analyze change in condition of the riverbank since previous FRRs; and
- Develop a final report, including maps delineating features identified in the field, which will document and summarize the findings of the 2013 FRR.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

As part of the current license requirements of the Northfield Mountain and Turners Falls Projects FirstLight is required to conduct a FRR every 3-5 years. Given the impending relicensing effort and timing of the next FRR (November 2013), FERC contacted FirstLight and indicated that the 2013 FRR should be folded into the relicensing.

In addition, MADEP, NHFGD, NHDES, NMFS, NHDES, and VANR, as well as stakeholder groups FRCOG, FCD, CRWC, LCCLC, and the Town of Gill, all submitted study requests pertaining to soils and geology. Study request tasks that were related directly to the goals and objectives outlined in the Study Goals and Objectives section above were incorporated in this reconnaissance level study. All other tasks were included in Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability or* not included in the PSP.

Resource management goals of the Agencies related specifically to this effort include documenting and describing the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In 1998, Simons & Associates (S&A) developed the "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River (ECP)*" (1999). As part of the ECP, FRR studies were conducted in 1998, 2001, 2004, and 2008 to document existing riverbank features and characteristics. The ECP and FRR studies are readily available for use as support documentation or as tools to compare past and present riverbank conditions.

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[4] At the June 14, 2013 study plan meeting, it was noted that the erosion investigation should be expanded to include identifying early stages of potential bank instability. Potential bank instability would include those areas where tension cracks, trees leaning toward the river, or other early stages of potential bank erosion are identified.

On January 22, 2013, FirstLight filed with FERC plan maps showing the location of 22 transects located in the Turners Falls Impoundment. Also provided were cross-section plots of these transects that have been surveyed twice annually since 1998. The transects can be used to compare bank erosion over time and to aid in the erosion trend analysis. Note that these transects were selected for two primary purposes (1) they were relatively evenly spaced along the entire impoundment from Vernon Dam to Turners Falls Dam and (2) most were located at sites where erosion was occurring.

Extensive research has been conducted evaluating erosion along the Connecticut River in the Turners Falls Impoundment; such research includes:

Connecticut River Joint Commissions and Trails Conservation Assistance Program of the National Park Service through the Connecticut Valley Partnership. (1996). *River Dynamics and Erosion.* Charlestown, NH: Author.

Field Geology Services. (2004). *Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire.* Farmington, ME: Author.

Field Geology Services (FGS). (2007). *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT.* Farmington, ME: Author.

New England Environmental (NEE). (2001). *Erosion Control Plan for the Turners Falls Pool of the Connecticut River*. Amherst, MA: Northeast Utilities Service Company.

New England Environmental (NEE). (2005). *Erosion Control Plan for the Turners Falls Pool of the Connecticut River, 2004 Full River Reconnaissance.* Amherst, MA: Northeast Utilities Service Company.

Simons & Associates (S&A). (1999). *Erosion control plan for the Turners Falls Pool of the Connecticut River. Prepared for Northeast Utilities*. Midway, UT: Author.

Simons & Associates (S&A). (2009). *Full river reconnaissance – 2008: Turners Falls Pool, Connecticut River*. Prepared for FirstLight Power Resources. Midway, UT: Author.

Simons & Associates (S&A). (2012a). *Analysis of Erosion in Vicinity of Route 10 Bridge Spanning the Connecticut River*. Prepared for FirstLight Power Resources, Midway, UT: Author.

Simons & Associates (S&A). (2012b). *Riverbank Erosion Comparison along the Connecticut River*. Prepared for FirstLight Power Resources, Midway, UT: Author.

Simons, D.B., Andrew, J.W., Li, R.M., & Alawady, M.A. (1979). *Connecticut River Streambank Erosion Study: Massachusetts, New Hampshire, and Vermont*. Waltham, MA: US Army Corps of Engineers (USACE).

Western Massachusetts Electric Company, (1995), *Long Term Riverbank Plan for Connecticut River between Vernon, VT and Turners Falls, MA.* Author.

US Army Corps of Engineers (USACE). (1991). *General investigation study - Connecticut River streambank erosion*. Waltham, MA: USACE, New England Division.

Project Nexus (18 CFR § 5.11(d)(4))

The Connecticut River is an alluvial river, subject to natural processes that result in dynamics such as lateral shifting, erosion, and deposition. These natural processes and dynamic response of the river is further affected by land-use practices, modified flow/water level regime, motorized boating, and other factors. Due to a variety of factors, the riverbanks along the Connecticut River, not just in the Turners Falls Impoundment, have a history of being susceptible to erosion. In accordance with the existing license requirements of the Turners Falls and Northfield Mountain Projects, a reconnaissance survey of the Turners Falls Impoundment was conducted in 1998 to map riverbank characteristics and prioritize erosion sites to be considered for stabilization. As a result of this work, the "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River (ECP)*" was developed by Simons and Associates (1999). The ECP requires FirstLight to conduct FRR studies every 3-5 years to continually monitor and evaluate erosion conditions throughout the Impoundment. As part of the FERC relicensing of the Turners Falls and Northfield Mountain Projects, the Commission has requested that the 2013 FRR be folded into a relicensing study.

Glossary

A glossary of technical terms used in this study is included at the end of Section 3.1.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The following methods will be used to document existing riverbank features and characteristics and to analyze any change in riverbank conditions since previous FRRs. Study methods will consist of the following tasks:

1) document current riverbank features and characteristics;

2) spatially define riverbank feature transition points;

3) map and develop distribution of riverbank features and characteristics including summary statistics (percentage distribution of the various features and characteristics including the length, type, and past management activities), evaluation of conditions in 2013 in context with changes in conditions from the previous FRRs studies, and other data to develop erosion trends in the Turners Falls Impoundment;

4) identify specific areas of slope instability and erosion prone reaches (where initial stages of erosion such as tension cracks and undercut toes are located); and

5) develop a final report and mapping.

The 22 river survey cross sections will be used in the FRR as part of the evaluation of trends in bank erosion (in other words, to quantify whether bank erosion is increasing or decreasing over time), and to be used as reference areas of bank conditions. As part of the geotechnical evaluation in Study 3.1.2, these locations will also be evaluated. Note that the task descriptions provided below are excerpts from the QAPP (Appendix D). It is recommended that stakeholders fully review Appendix D.

This study will include the entire length of the Turners Falls Impoundment from Vernon Dam to Turners Falls Dam to show the full range of conditions that are observed within this reach and to be consistent with previous FRRs. Islands within the Turners Falls Impoundment are to be included in the study.

Task 1: Document Existing Riverbank Features and Characteristics

Task 1a: Identify and Define Current Riverbank Features and Characteristics

Current riverbank features and characteristics will be identified and defined through the use of a pre-determined matrix of nine riverbank criteria (see Table 3.1-1). The matrix of features and characteristics utilized in 2008 was based on experience from previous FRR efforts, including 2004, and discussion with the CRSEC. In addition to the written descriptions, representative line drawings and photographs have been included to clarify each of these features. The matrix will be utilized in the field and for each riverbank segment each of the nine riverbank features on the left-hand column (highlighted in grey) will be classified by applying the range of characteristics in the remaining right hand columns (not highlighted). This information will be entered into the data-logger. Thus for each segment of riverbank, the upper riverbank slope will be classified as to whether it is overhanging, vertical, steep, moderate, or flat; the lower riverbank will be classified as to whether it is vertical, steep, moderate, or flat; the upper and lower riverbank materials will be classified as to whether they consist of silt/sand, gravel, cobbles, boulders, bedrock, or clay; the height of the upper riverbank will be classified depending on if it is high, medium or low; and so on going through the entire matrix until it has been completed for each segment of riverbank.

Several steps will be taken to ensure consistent and reproducible identification and definition. First, attached to this study plan are photographs and cross section drawings which are to provide a visualization for each of the characteristics in the matrix shown in Table 3.1-1. Second, a glossary of terms, based on generally accepted scientific or regulatory definitions, is also provided. Third, the matrix itself consists of 9 riverbank features that include such items as riverbank geometry (upper and lower riverbank slope and upper riverbank height), riverbank materials (upper and lower riverbank sediment), vegetation (upper and lower riverbank degree of vegetation), and erosion (mass wasting and erosion type. The same matrix of riverbank features and characteristics is proposed for the boat-based portion of the 2013 FRR providing a consistent basis for comparison with past FRR efforts (see Table 3.1-1).

The FRR report will include maps for each of the 9 riverbank features in the matrix (Table 3.1-1, vertical left-hand column) with each segment categorized as shown in the other columns (2-7). For example, in the case of upper riverbank sediment, maps will be developed showing all segments surveyed covering the length of the Turners Falls Impoundment and the particular type of upper riverbank sediment associated with each segment (i.e., the map will show which segments consist of silt/sand, gravel, cobbles, boulders, bedrock, or clay). Similarly, a map of the types of erosion for each segment of river will be provided showing where areas of overhanging bank, undercut toes, notching and slides are located. So maps for each of the nine riverbank features, delineating segment by segment the characteristics of each feature, will be developed and included in the report as it was in 2008 and other previous FRRs. Examples of these maps are shown in Task 6 which discusses the report and deliverables for the FRR. A statistical summary of each riverbank feature and the extent of each characteristic within each feature will be provided. These data will allow for the evaluation of individual features (e.g. mass wasting), or for the entire spectrum of features and characteristics.

A key aspect of the FRR is how the range of riverbank features and characteristics are classified in the field. To understand and demonstrate the classification process, photographs were taken in November 2012 during leaf-off conditions, representing similar conditions for the 2013 FRR. Appendix C of the QAPP (Appendix D) contains photographs covering the features and range of characteristics from Table 3.1-1. QAPP Appendix C also includes photographs from previous years to ensure complete coverage of the matrix.

These photographs will provide a consistent guide as to how riverbank features and characteristics will be classified. Particular segments of the riverbank will be classified and entered into the data logger based on certain features and characteristics observed on the riverbank(s) and found in the photographs. As discussed in Task 1b, the use of geo-referenced digital video will provide a means of verifying the observed features and characteristics of any riverbank segment in comparison to the observations entered in the data-logger.

Table 3.1-1: Connecticut River – Turners Falls Impoundment Riverbank Characteristics Matrix for Boat-based Survey, field data logging worksheet

Upper Riverbank Slope	Overhanging *>90°*	Vertical *90°*	Steep *(>2:1)*	Moderate *(4-2:1)*	Flat *(<4:1)*	
Lower Riverbank Slope	Vertical *90°*	Steep *(>2:1)*	Moderate *(4-2:1)*	Flat *(<4:1)*		
Upper Riverbank Sediment	Silt/Sand *<.062mm-2.0mm*	Gravel *2.0mm-64mm*	Cobbles *64mm-256mm*	Boulders *256mm-2048mm*	Bedrock	Clay
Lower Riverbank Sediment	Silt/Sand *<.062mm-2.0mm*	Gravel *2.0mm-64mm*	Cobbles *64mm-256mm*	Boulders *256mm-2048mm*	Bedrock	Clay
Upper Riverbank Height (total height above normal river level)	Low *(<8 ft.)*	Medium *(8-12 ft.)*	High *(>12 ft.)*			
Degree Upper Riverbank Vegetation	Heavily Vegetated *>50% cover*	Moderately Vegetated *26%-50% cover*	Sparsely Vegetated *11%-25% cover*	None to Very Sparse *<0%-10% cover*		
Mass Wasting (extent of erosion)[5]	None	Moderate	Extensive			
Erosion Type[6]	None	Overhanging Bank	Undercut Toe	Notching	Slide, slump, mass-wasting,	New erosion
Lower Riverbank Vegetation	None *0% cover*	Heavy *>50% cover*	Moderate *26%-50% cover*	Sparse *1%-10% cover*		

[5] Mass-wasting is defined as the movement of blocks or other pieces of riverbank material downslope under the influence of gravity. Minor or insignificant amounts of erosion can be found in virtually all riverbanks. When a riverbank is characterized as being in the little/none category this means that only minor or insignificant to no erosion was observed. Erosion is not necessarily continuous throughout the length of any particular segment of river, particularly those segments characterized as having "some" mass-wasting.
[6] Frequently, different types of erosion occur at the same location. In these instances, the dominant type of erosion will be used when characterizing a particular segment of river.

Each of the riverbank features and characteristics outlined in Table 3.1-1 are shown photographically in an appendix of the QAPP. In addition, a glossary of terms, including those utilized by Field regarding stage of erosion, has been developed and discussed regarding comparing Fields definitions to those utilized in the matrix. This is found at the end of this FRR study plan.

A riverbank consists of a combination of features with a range of characteristics that either work together in resisting erosive forces, or together suffer various degrees of failure or susceptibility to erosion. Riverbanks in the Turners Falls Impoundment generally consist of an upper bank that is often above water except during high flow conditions, and a lower bank that is frequently submerged. These banks consist of a range of materials from silt or sand to solid rock. The banks support a range of vegetation conditions and a range of heights. The riverbanks experience a range of conditions of stability or erosion. This combination of features and associated range of characteristics or attributes are described in the matrix in Table 3.1-2. This matrix represents one of several approaches in understanding and evaluating the data and was developed based on input received at the previous CRSEC meetings and experience from all previous reconnaissance efforts. These data are used to create the mapping products of the FRR. The grouping approach combines riverbank features and characteristics into key associations that can provide insight into which features and characteristics are associated with stability and which are associated with erosion. Statistical distributions of characteristics within each group can aid in further understanding erosion and stability issues such as which combination of features and characteristics trend towards stability, and which trend toward erosion. Such information and understanding can aid in the planning process in developing appropriate approaches in addressing erosion issues.

Information showing all of the features and characteristics from the matrix in Table 3.1-1, as well as the riverbank characterization groups, will be developed into maps.

Table 3.1-2: Riverbank Characterizations

Group	Mass Wasting	Erosion Type	Degree Upper Riverbank Vegetation	Upper Riverbank Slope	Upper Riverbank Sediment	Lower Riverbank Slope	Lower Riverbank Sediment	Upper Riverbank Height	Lower Riverbank Vegetation
1	Extensive	Overhanging to Slide	None to Heavy	Flat to Overhanging	non-Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy
2	Moderate	Overhanging to Slide	None to Heavy	Flat to Overhanging	non-Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy
3	None	None	None to Sparse	Flat to Overhanging	non-Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy
4	None	None	Moderate to Heavy	Steep to Overhanging	non-Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy
5	None	None	Moderate to Heavy	Moderate	non-Rock	Moderate to Vertical	Silt/Sand to Rock	Low to High	None to Heavy
6	None	None	Moderate	Moderate	non-Rock	Flat	Silt/Sand	Low to	None to

Group	Mass Wasting	Erosion Type	Degree Upper Riverbank Vegetation	Upper Riverbank Slope	Upper Riverbank Sediment	Lower Riverbank Slope	Lower Riverbank Sediment	Upper Riverbank Height	Lower Riverbank Vegetation
			to Heavy				to Rock	High	Heavy
7	None	None	Moderate to Heavy	Flat	non-Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy
8	None	None	None to Heavy	Flat to Overhanging	Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy

Comparison of Field's stage of erosion to Table 3.1-1 Matrix of Riverbank Features and Characteristics

Field's Figure 30 presents 6 stages of erosion as presented above. These 6 combinations of riverbanks provide useful information on possible combinations of riverbank features and characteristics. The matrix of riverbank features and characteristics utilized in the 2008 FRR and proposed for the 2013 FRR provide a comprehensive set of key features and characteristics, including those outlined by Field, 2007. The use of the matrix allows for a detailed and comprehensive approach in classifying riverbanks and allows development of a detailed and comprehensive understanding of riverbanks. Each of the stages described in Field's Figure 30 is included in the matrix as shown in Table 1. Inclusion of the six descriptions of riverbanks developed by Field and the numerous other possible sets of riverbank features and characteristics in the matrix provides a comprehensive set of riverbank features and characteristics that both describe the riverbank conditions as observed in the field, as well as the stages of erosion as described by Field.

Table 1. Comparison of Field's stage of erosion with matrix of riverbank features and characteristics

Field	Matrix
a) Stable bank	Upper bank slope (flat to steep), Upper bank vegetation (moderate to heavily vegetated as well as even less vegetated conditions), with little to no erosion,
b) Notching or undercutting	Erosion Type: Undercut toe, notching; Degree of erosion: (little/none, some, extensive)
c) Slide or topple	Erosion Type: Slide; Degree of erosion: (little/none, some, extensive)
d) Flows (disaggregated slide)	Erosion Type: Slide; Degree of erosion: (little/none, some, extensive)
e) Secondary notching or undercutting	Erosion Type: Undercut toe, notching; Degree of erosion: (little/none, some, extensive)
f) Bare bank with beach	Upper bank slope with none to very sparse upper bank vegetation, flat lower bank slope

The table shows that each of the six stages of erosion is included in the matrix as shown in Table 1. Beyond these six, the matrix provides for hundreds of possible combinations of riverbank features and characteristics. Photographs of each of the specific features and characteristics are provided in the QAPP.

Task 1b: Geo-referenced Video

As a means of data control and reference checking, a geo-referenced video will be taken of the riverbanks of the entire Turners Falls Impoundment. This technique allows for the capture of both digital video images and their location along the riverbank. Geo-referenced video provides a method to verify what the riverbanks looked like during the 2013 FRR as well as the locations of the video scenes along the length of the Turners Falls Impoundment. If questions arise as to how a riverbank segment was classified, the videotape can be checked to evaluate the specific features and characteristics. Video of the riverbank will be taken either before or after the riverbank classification from a boat at approximately 50 feet from the bank line.

The geo-referenced videotaping will be conducted using the Red Hen Systems equipment (which was utilized in 1998, 2001, 2004 and 2008). Red Hen Systems provide hardware and software to collect geo-referenced video and photo data in the field, and brings that data into desktops and Web-based maps for analysis and decision making processes. Red Hen Systems includes three components: the VMS-HDII (which includes the VMS-333 geo-referencing equipment); the nanoFlash video recorder from Convergent; and MediaMapper Software. Appendix D of the QAPP (Appendix D) provides detailed information on this system from the Red Hen Systems website (http://www.redhensystems.com).

Task 1c: Land-Based Observations

Both the MADEP and the CRSEC have requested future FRR surveys to include a land-based evaluation. The MADEP has suggested that the boat surveys could be eliminated in favor of a geotechnical evaluation of specific areas of slope instability within Turners Falls Impoundment. The CRSEC is in favor of the boat-based survey in addition to a land-based assessment of the entire Impoundment. It is proposed as part of this FRR Study to continue to document and map the entire Turners Falls Impoundment using the boat-based surveys, but to additionally conduct land-based evaluations along the Turners Falls Impoundment. A land-based bank assessment looking at specific areas of slope instability and erosion prone areas will be implemented as part of the 2013 FRR study. The land based observations will be made on the entire riverbank by walking along the bank except in areas where access is not possible or dangerous (e.g. bridge crossings), or where bank conditions do not warrant assessment (e.g. bedrock areas). along the entire length of the impoundment except in areas that are impassable such as French King Gorge and areas of structural or other impediment. The field work will be conducted by the fluvial geomorphologist/hydraulic engineer, geotechnical engineer, and riverbank stabilization/environmental consultant. Observations will be documented of any erosion or riverbank instability including geo-referenced photographs. Specific erosion phenomena observed include such items as tension cracks, gullying, lack of riparian vegetation, slips or slides, or other erosional features which are to be documented in Study 3.1.2 by the geotechnical and geomorphic evaluations of the riverbanks. Particular attention will be given to identify areas in an early stage of bank erosion. Geotechnical observations of erosion from the land-based work will be documented as described in Table 3.1-3. This table of land-based observations is in addition to and complementary with the boat-based observation matrix. Work is anticipated to be conducted in the Fall of 2013. An in-depth geotechnical analysis will be conducted as part of Study 3.1.2 and the bank erosion data integrated into the FRR mapping products.

Site specific bank characteristics will be provided during the land-based observations as part of Study 3.1.2. The location of the beginning and end points of these features will be collected via sub-meter GPS.

Observations will be entered into the data-logger and backed up by geo-referenced digital photograph and/or video documentation. In order to provide information to better understand the conditions related to erosion at each observation. The geotechnical engineer will develop a field sheet, similar to that developed by the US Army Corps of Engineers (1992) for field assessment of bank conditions.

The FRR mapping process will consist of a combination of the boat-based survey following the matrix of riverbank features and characteristics in Table 3.1-1 and the observations of the land-based erosion as documented in Table 3.1-3. Both the boat-based survey and the land-based observations will be utilized in collecting data in the field and in developing the FRR report and maps.

As part of Study 3.1.2 additional land-based field work will evaluate the existing 22± river cross sections which were established in 1998 and surveyed periodically to document bank erosion. The locations of these cross sections are included in Appendix H. Additional survey locations may be included in Study 3.1.2. Significant erosion areas, specific areas of slope instability (e.g. tension cracks or evidence of mass-wasting, and other forms of erosion) will be evaluated by the geomorphologist/hydraulic engineer and geotechnical engineer.

Table 3.1-3: Land-Based Erosion Evaluation Form

Right or Left Bank (looking downstream)	Coordinates Start-End	Distance from River	Height above River	Type of Erosion*	Description/ Comments

**Type of Erosion: Erosion types identified will include, but not be limited to, the following: tension cracks, gullies, slides, slips, slumps and falls.*

Task 2: Spatially Define Riverbank Feature Transitions

The locations of transition points, or end points, from one riverbank feature or classification to another will be captured via sub-meter GPS in a standard coordinate system (i.e. NAD 83 State Plane or UTM coordinates). In order to capture these locations, FirstLight will utilize standard field equipment including three field instruments: 1) a sub-meter GPS; 2) a data-logger; and 3) a laser range-finder.

The individual conducting the classification will select a point of transition from one category of riverbank to another and "shoot" this point with the laser range-finder. The features and characteristics of the next riverbank segment will be classified and verbally transmitted from the individual conducting the expert classification to the individual operating the data logger who then records the observational data while the position information (location of the GPS antenna and distance and azimuth from the laser rangefinder to the selected point on the riverbank) is automatically recorded when the trigger is pulled on the laser rangefinder. The data logger acknowledges that the positional data has been recorded and the individual operating the data logger can ensure that the observations corresponding to that point have been entered. Appendix A and B of the QAPP (Appendix D) provide specifications for the sub-meter GPS and laser range-finder models that have been selected for this survey.

The accuracy of a sub-meter GPS is assumed to be less than one meter; however, the accuracy of any GPS in the field depends on the availability of a sufficient number of satellites and the correction that is applied that ultimately defines the actual accuracy when locating a point on the ground. Prior to initiation of GPS mapping, the location/time of day of the satellites will be determined for optimal GPS readings. The GPS determines the location of the boat from where the observation of the riverbank features and characteristics is made, and the offset and azimuth to the riverbank is made using the laser rangefinder.

The position of the riverbank point will be shot from the boat using a laser rangefinder. The accuracy of a mapping grade laser rangefinder is +/- 1 foot for distance and +/- 1 degree for azimuth. Assuming the length of the shots from the laser rangefinder is 100 feet, an accuracy of one degree translates into about +/- 1.7 feet distance when projected along the length of the bank (100 times sine of 1 degree). The combination of the accuracy of the sub-meter GPS and the laser rangefinder would then be approximately +/-6 feet, with an estimated accuracy of within 10 feet for 90% of the measurements made.

Prior to initiation of the FRR mapping the positional accuracy of the GPS/laser rangefinder system will be determined via field test. A known, fixed point will be located on the bank from a slow moving boat. The GPS unit and laser rangefinder will then be used to collect the known points' location. The point will be surveyed multiple times and the difference in location will be determined.

The approach of using sub-meter GPS with laser rangefinder is a sufficiently accurate technique to map bank erosion in long river reaches, particularly given the variability of biologic and geologic identification of the specific transition points between one riverbank segment and another.

The level of discretization of riverbank segments depends on the frequency of transitions between the various features and characteristics observed in the field. There is no set distance of segmentation along the river. Previous FRRs have resulted in a range of segment lengths from 20 to over 4000 feet, with average segment lengths from 480 to 1267 feet. The 2008 FRR resulted in the smallest average segment length and greatest degree of discretization of the various FRRs compared ("*Response to Field Geology Services' 2011 'Detailed Analysis of the 2008 Full River Reconnaissance of the Turners Falls Pool on the Connecticut River," July, 2012*). The 2013 FRR will result in a range of segment lengths and degree of discretization consistent with the frequency of transitions of features and characteristics found in the Turners Falls Impoundment and will likely result in a similar level of discretization as the 2008 FRR. Segments as short as 20 feet will be documented based on the observation of features and characteristics. The speed at which the survey will be conducted is dictated by the efficiency of the observer/data logging team and is constantly varied to match field conditions, including reversing the boat and passing by riverbank features again. The data logger files contain the coordinates of the segments that were covered during each day of field work and will show the length of river covered for each day and hence the rate of data collection. The information regarding the rate of boat-based field observation, and the level of effort of work will be summarized and included in the final report.

<u>Task 3: Land-use Mapping</u>

A land use plan will be developed to evaluate trends in bank erosion in relation to the adjacent land use. The plans will be developed using MASSGIS data layers of land use. The maps will include property ownership information obtained from the Town Assessor's. Existing aerial photographs will be used to determine the width of riparian buffers, and additional land use information. On-the-ground field assessment will be used to determine the agricultural land use in 2013 (e.g. row or cover crop, measurement of riparian areas, and other land use data not apparent from the remote sources. These data will be mapped for an area of 200 feet horizontally from the Mean Annual High Water line, or the top of the slope, which ever is greater.

<u>Task 4: Develop Maps, Summary Statistics, Evaluation of Conditions, and Analyze Changes in Condition since Implementation of ECP and from 2008 FRR</u>

Segmentation of all riverbank features and characteristics will be developed showing the longitudinal extent and distribution along the Turners Falls Impoundment. Summary statistics quantifying the lengths of features and characteristics will be calculated. Conditions in 2013 will be evaluated based on comparisons over time of the river going back as far as the implementation of the ECP (1999).

Once all field efforts, post-processing, and development of the spatial segmentation of riverbanks are completed, analysis of the 2013 field data will be conducted to develop summary statistics of the riverbank classification. Maps showing all riverbank features and characteristics within each feature will be developed in ArcGIS showing results of the 2013 FRR. Geo-referenced video from the boat-based field work and geo-referenced photographs from the land-based field work will be available in documenting and analyzing the condition of riverbanks. Comparisons of riverbank conditions will be made back to the time of the initial FRR (in 1998 as part of the ECP) and other FRRs using overall summary statistics of riverbank features and characteristics (as collected data using Tables 3.1-1 and Table 3.1-2, photography, and results from Study 3.1.2. A comparison of the 2013 FRR will be made to the previous FRRs using summary statistics and analysis in ArcGIS, accounting for any differences in methods and considering the accuracy of the technology utilized in collecting the spatial component of the data. Comparison efforts may include analyzing changes in the length of riverbank shoreline experiencing erosion, severity of erosion, length of riverbank stabilization, success of erosion remediation efforts, identification of new erosion areas, etc. [7]The purpose of these comparisons is to evaluate the trends in river bank erosion, and to see if an equilibrium of erosion and stabilization is developing.

The FRR will include mapping and description of riverbank features and characteristics where active or recent bank erosion is occurring at the time of the field work. Additionally, bank areas in an early stage of erosion will be mapped.. Areas of erosion adjacent to previous bank stabilization will be identified and discussed in context of the type of stabilization utilized. Additionally, land-use practices that are related to riverbank erosion processes will be mapped as part of the land-based component of the FRR.

Maps showing location and extent of the range of sediment types will be generated based on the sediment classifications of the upper and lower riverbanks included in the matrix of features and characteristics. Sediment classification is sub-divided into 6 key categories ranging from clay, silt/sand, up through boulders and bedrock; allowing for easy understanding of which areas consist of erodible soils (e.g. unconsolidated silt, clay and sand) and which are not – including the location and extent of bedrock.

“Sensitive Receptors” identifying the location of important wildlife habitat use on or near the river banks (e.g. bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.) will be mapped.

A Land Use map will be developed showing the current land uses (e.g. forest, agriculture, conservation, utility, developed, etc. and the width of the undisturbed forested riparian zone.

[7] Each FRR is internally consistent regarding the characterization of riverbank segments and overall length of river covered in the mapping. Summary statistics (either in terms of lengths of the various features and characteristics or percentages of the overall length) can be compared between each of the FRRs conducted over time. In other words, the percentage or length of riverbank that is in a given category, such as severely eroded, based on one FRR; can be compared to the percentage or length of riverbank that is in that same or similar category (accounting for the overall length of riverbank surveyed in one FRR compared to another). So any identically or reasonably similar category from one FRR can be compared to another on an overall length or percentage basis. A direct comparison of maps in GIS software is not appropriate unless the differences in survey equipment and techniques are quantitatively addresses and incorporated into the analysis. This can be done by putting +/- accuracy bands around all transition points between all segments for each FRR being compared and eliminating these bands from direct comparison. Only segments with the accuracy bands eliminated can be used for direct spatial comparison. This is the type of approach has been utilized in comparing changes in channel geometry or bathymetry over time between successive surveys on other projects. To conduct a direct comparison without this key step may result in erroneous analysis and invalid conclusions.

Task 5: Evaluation of Riverbank Stabilization Projects

A map will be developed of all restoration projects within the Turners Falls Impoundment completed since 1996, as well as the location of previously restored areas including rip-rap, vertical structures, and Corps projects. The FRR will provide a summary of each of the restoration projects constructed as part of the ECP. Descriptions of the successes and failures of each design, construction implementation, revegetation and invasive species concerns as well as long term maintenance recommendations will be included in this study.

Recommendations for potential future stabilization projects will be included in the final report of the FRR.

Task 6: Develop Final Report, Mapping, and Recommendations

Following post processing and analysis of field data, a final report documenting the methodology and results of the 2013 FRR study will be generated, including discussion of summary statistics and comparisons over time with previous FRRs. In addition, summary maps and maps delineating all features and characteristics captured during field efforts will be generated in ArcGIS. Maps will be made available digitally as well as in the final report.

The following deliverables will be included in the 2013 FRR report:

Deliverables:

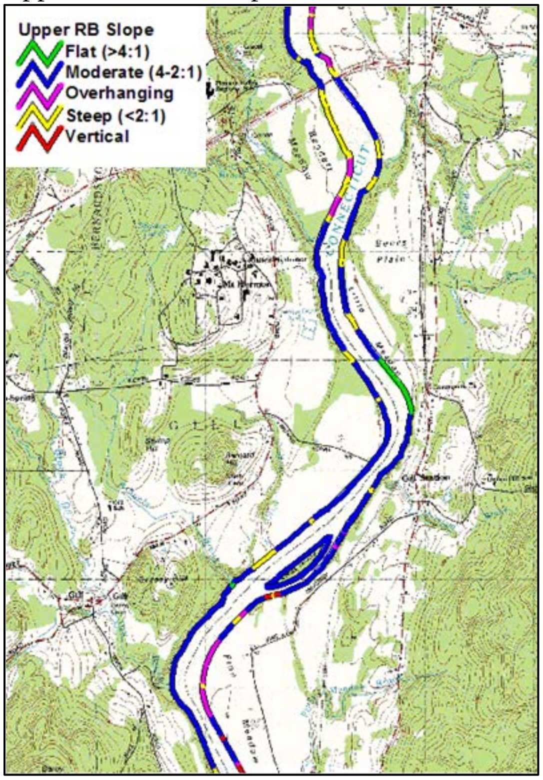
1. Surficial Geology Map
2. Riverbank slope map (upper and lower bank)
3. Riverbank surficial sediment/substrate map (upper and lower bank);
4. Riverbank height map;
5. Riverbank vegetation map;
6. Mass-wasting (erosion) map;
7. Erosion type map;
8. Riverbank group features and characteristics map;
9. Early stage of erosion map;
10. Adjacent land-use map;
11. Sensitive receptors map;
12. Surficial geology map;
13. Riverbank stabilization project site map;
14. Recommendation of potential future stabilization project map;
15. Geo-referenced video; and
16. Final Report (Including: summary statistics of riverbank features and characteristics; data-logging and field forms; photographs; overall assessment of erosion within the Turners Falls Impoundment, long term trends and comparison of FRRs over time; evaluation of existing stabilization projects; sediment deposition at stabilization sites; and recommendations for future preventative maintenance and bank stabilization work. Summary of land-based erosion evaluations; recommendations for riparian buffers based on the land use plan and adjacent erosion will be provided. Recommendations for avoidance or protection of sensitive receptors, and significant wildlife habitat areas. Raw data will be provided.

Examples of the map details from the 2008 FRR mapping are included in Figure 3.1-1. 2013 FRR mapping will follow previous FRR mapping styles so that data are comparable.

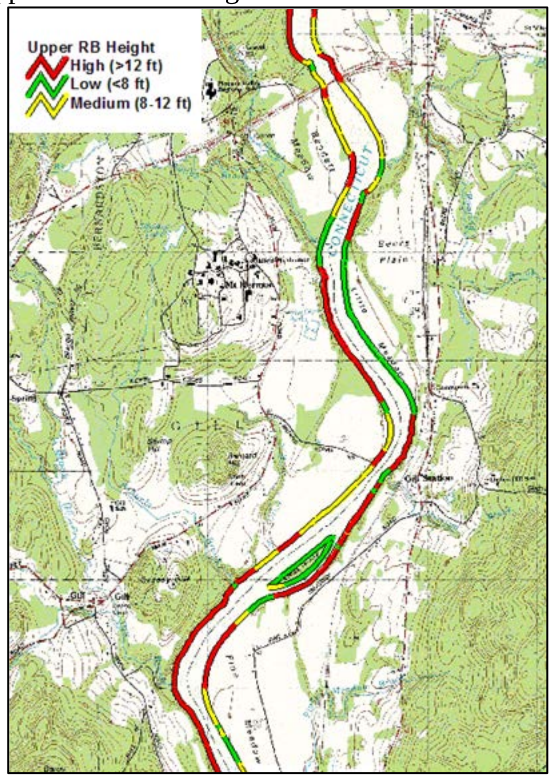
The report will also be reviewed and assessed by a professionally qualified archaeologist, and initial management recommendations will be made in the Phase 1A report, as appropriate, which is being prepared as part of the *Phase 1A Archaeological Survey* (Study No. 3.7.1).

Figure 3.1-1: 2001 FRR maps for Height, Slope, Vegetation, and Material

Upper Riverbank Slope – Section 3

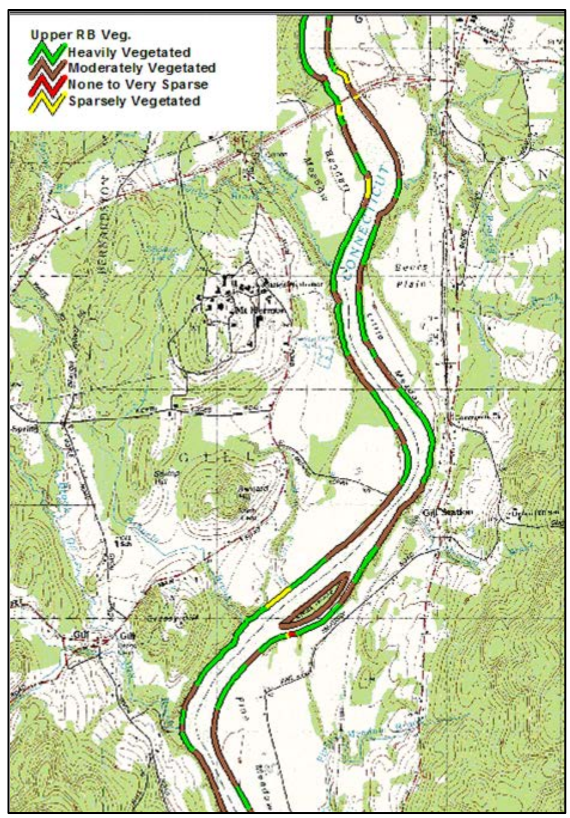


Upper Riverbank Height – Section 3



Lower Riverbank Sediment – Section 2

Upper Riverbank Vegetation – Section 3



Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort defined above is adequate to conduct a comprehensive full river reconnaissance study. The estimated cost for this study is between $250,000- $450,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight is proposing to initiate land-based studies in the early fall of 2013 and the full river mapping in the fall (mid November 2013) during leaf-off conditions. Based on the ILP schedule, and assuming there is no dispute with this particular study, FERC would issue its study plan determination letter by September 12, 2013. This would allow sufficient time to conduct the November 2013 FRR. FirstLight is seeking to file the final report in September 2014 to match the timeline for filing other relicensing studies and will request FERC to provide an extension from the current April 2014 due date. If FERC grants the extension, if an agency with mandatory conditioning authority disputes this particular study, FERC would not issue its study plan determination letter until December 11, 2013. Thus, FirstLight would have to delay conducting the 2013 FRR until 2014.

Glossary to be used in FRR mapping and reporting

Erosion: particle by particle removal of sediment from a sediment surface due to the action of water (or wind) on the surface layer of sediment. Mass wasting may also be considered a form of erosion.

Mass Wasting: movement of blocks or pieces of riverbank material downslope under the influence of gravity.

Mean Annual High Water. Defined in the Massachusetts Wetlands Protection Act as the line apparent from visible markings and changes in soils and vegetation from the prolonged presence of water and which distinguishes between predominantly aquatic and terrestrial land. Determined by characteristic features indicative of fluvial processes.

Frost Wedging. A process of physical weathering in which water freezes in a crack and exerts a force on the soil or rock causing further rupture. Frost action generally occurs on poorly drained soils, such as clay, and often results in the development of heaves or depressions.

Geotechnical Failures. These failures that are unrelated to hydraulic failures are usually a result of bank moisture problems. Failures are often the result of the shear strength of the bank material being exceeded. Characteristics of geotechnical failures can vary, although mass wasting of soil at the toe of the bank is often one indicator.

Gully erosion. The consequence of water that cuts down into the soil along the line of flow. Gullies form in natural drainage-ways, in plow furrows, in animal trails, in vehicle ruts, and below broken man-made terraces.

Hydraulic Failures. Characterized by a lack of vegetation, high boundary velocities, and no mass soil wasting at the toe of the slope. This type of erosion occurs when flowing water exerts a tractive force that exceeds the critical shear stress for that particular streambank material.

Mass Wasting. This term, also called mass movement, encompasses a brad array of processes whereby earth material is transported down a slope by the force of gravity. Varieties of mass wasting are classified according to the speed and force of the process, from extremely slow creep to very rapid, dramatic slides and falls. There are three generally recognized types of mass wasting: flow, slide, and fall. Some geologists and geomorphologists also include slump (rapid mass-wasting), and creep (slow) in these categories.

Rill Erosion. The removal of soil through the cutting of many small, but conspicuous channels where runoff concentrates. Rill erosion is intermediate between sheet and gully erosion. Rilling is the most common process of rainfall erosion.

Rockfall. A type of mass movement that involves the detachment and movement of a small block of rock from a bank face to its base. Normally occurs when the material has well defined bedding planes that are exaggerated by freeze-thaw action or thermal expansion and contraction.

Rotational Slip. A downward mass movement of unconsolidated soil material that moves suddenly along a curvilinear plane. Groundwater exerts outward pressure on soil particles and causes a seep which creates a landslide. Additional causes include increased weight, toe erosion and saturated conditions. This process is also called a slump or slide.

Wave Action. The impact of waves hitting directly on exposed soil. Waves vary with wind speeds and duration, water depth, and the continuous length of water over which winds blow in one direction. Waves can also be created by boat traffic near shorelines.

Riverfront Area. The area of land between a river's mean annual high water line measured horizontally outward from the river and a parallel line located 200 feet away. A term used in the Massachusetts Wetlands Protection Act.

Toe of Slope. The base or bottom of a slope.

NOTE: Other terms may be added to glossary as the study plan is completed. Except where noted, terms used are from Fischenich, 1989 and Leopold, 1994.

Various types of erosion were described through schematic drawings in the 1979 USACE report as shown in the following figures:

Tension Crack:

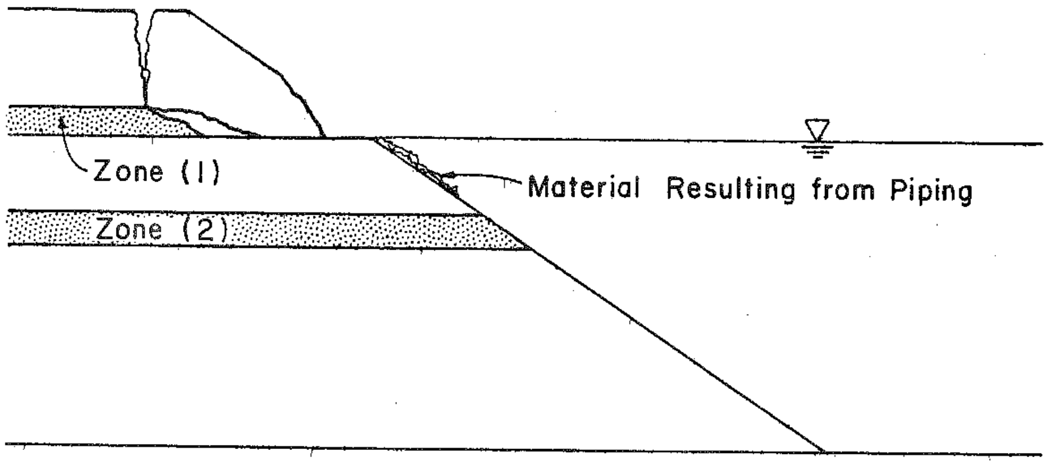


Figure 39. Development of tension crack.

(after USACE, 1979)

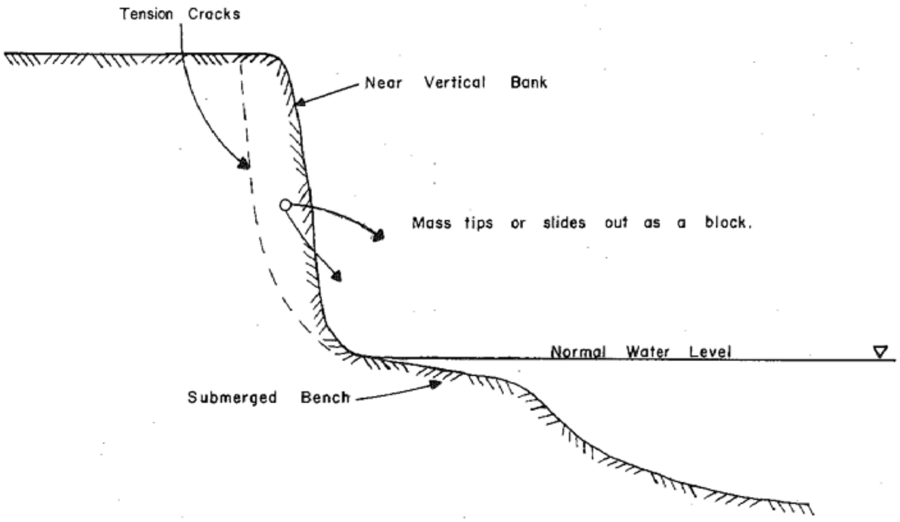


Figure 59. Mass wasting on a vegetated or barren bank.

(after USACE, 1979)

Slide (or sloughing):

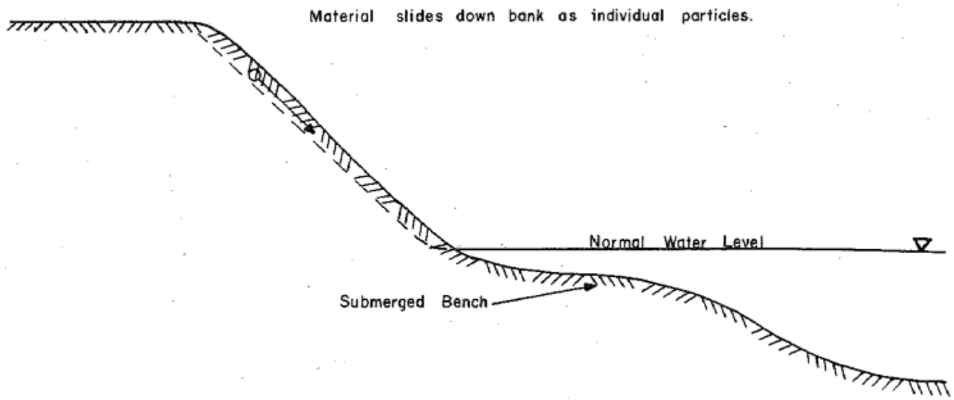


Figure 60. Sloughing on a partially vegetated or barren bank.

(after USACE, 1979)

Undercut Toe:

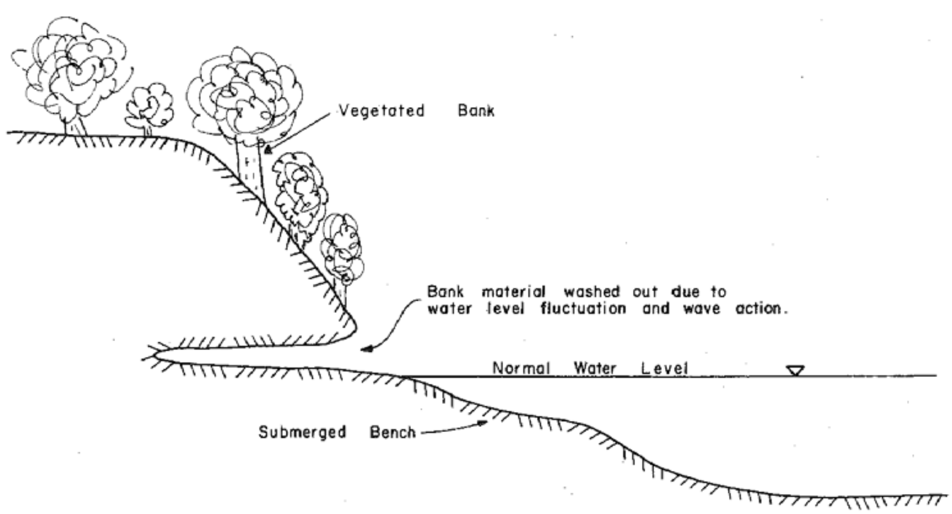


Figure 63. Undercutting on a vegetated bank.

(after USACE, 1979)

Notching:

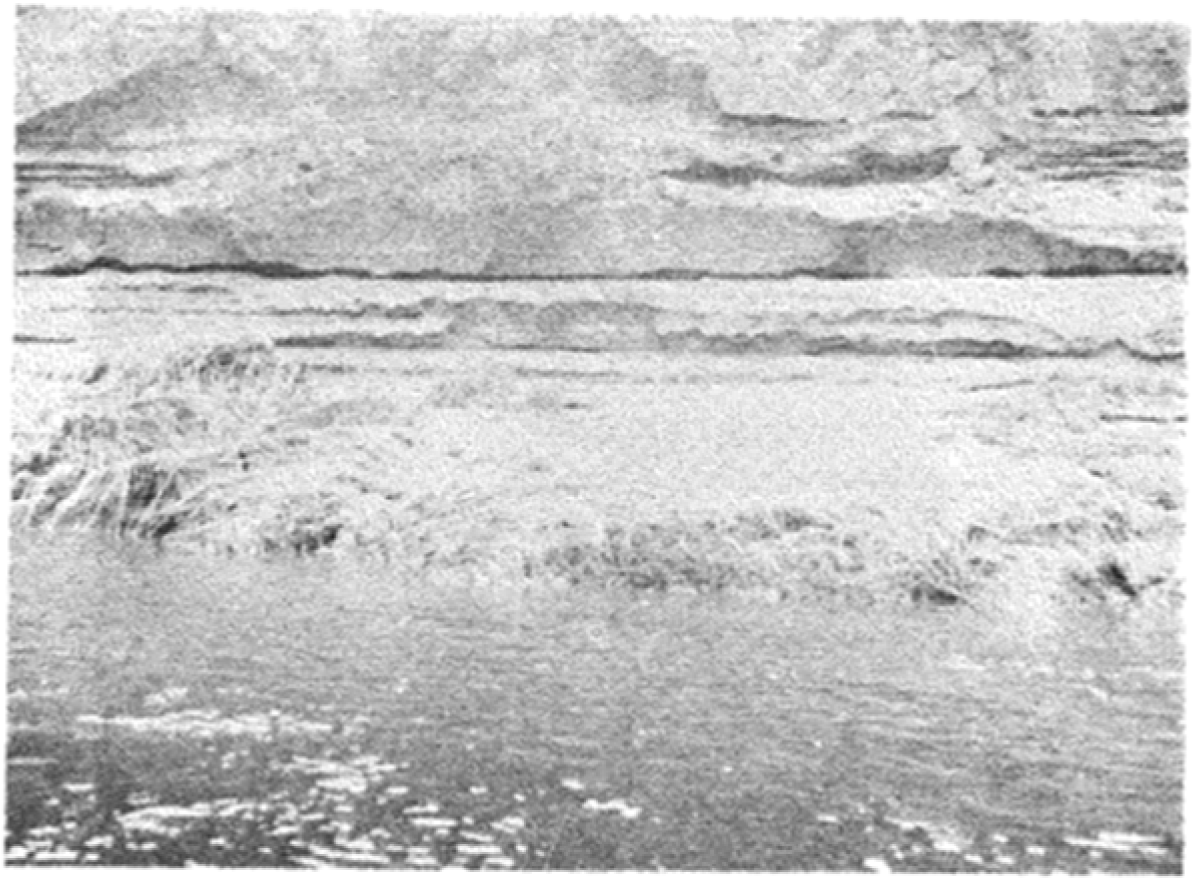


Figure 68. Undercutting on a vegetated bank.

(after USACE, 1979 – called undercutting in this photo but better represents notching which leaves a vertical stepped face probably after small undercut areas have failed)

Beach Formation (referred to as berm in USACE, 1979):

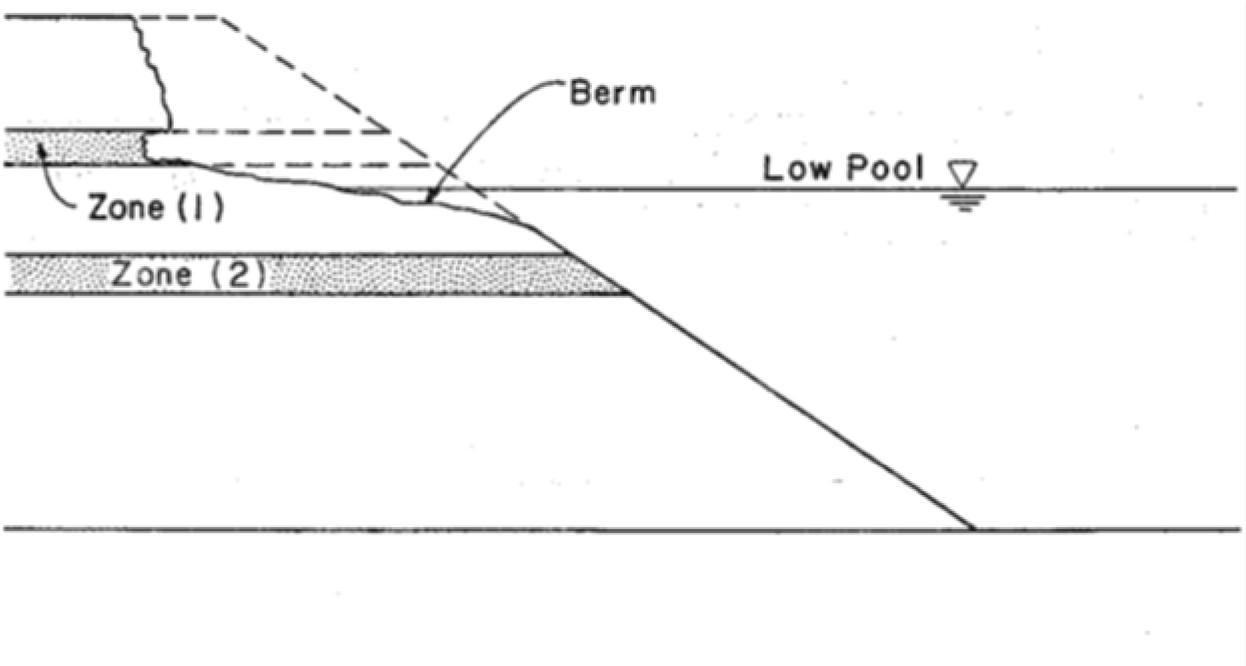


Figure 40. Development of berm.

(after USACE, 1979)

Stage of Erosion (Field, 2007)

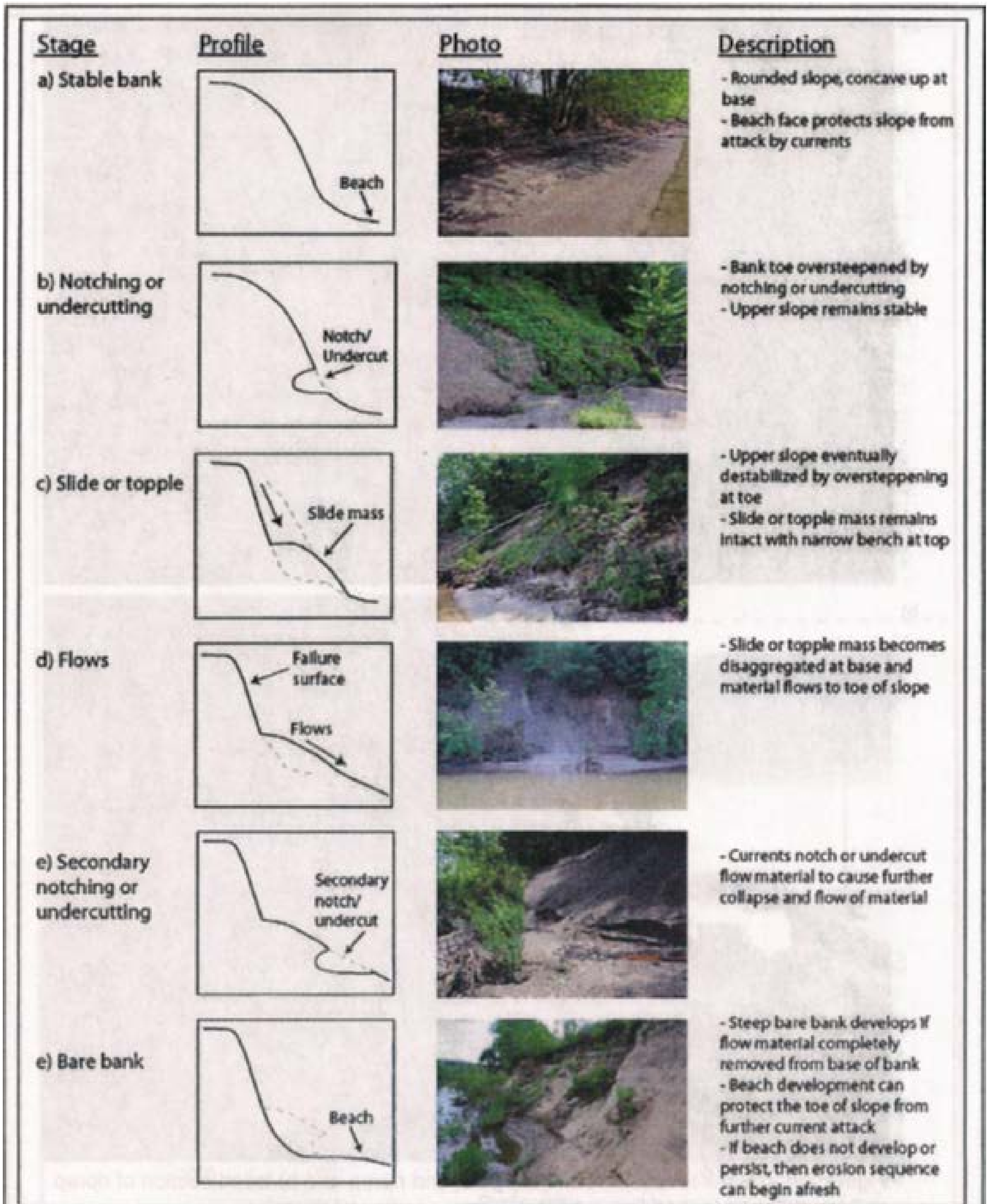


Figure 30: Model illustrating idealized sequence of erosion. Different stages of erosion can be occurring adjacent to each other along a long continuously eroding bank.

3.1.2 Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability

General Description of Proposed Study

This study was requested by the MADEP; however, several other stakeholders (FRCOG-2[8], CRWC-2, FCD-2, Town of Gill-2, and LCCLC-2a) had a similar study request containing many of the same study objectives and elements as the MADEP. The latter group requested the same study entitled: "*Study the Impact of Operations of the Northfield Mountain Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River*". FirstLight is addressing many of their study objectives/elements in this study; however, those study objectives/elements not proposed are summarized in Section 4.0 Studies Not Included in the PSP- see Study No. 4.1.2.

The study calls for evaluating the causes of erosion in the Turners Falls Impoundment and determining if they are related to project operations.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The study goals include:

- Develop a comprehensive understanding of riverbank erosion and potential bank instability[9] in the Turners Falls Impoundment from a fluvial geomorphic and geotechnical perspective.

- Conduct a focused investigation of existing and potential bank instability in the Turners Falls Impoundment in those areas where soils are erodible.

The study objectives include:

- Determine the causes of existing and potential bank instability from a fluvial geomorphic and geotechnical perspective in those areas where soils are erodible and to quantify the relative effect of the various causes of erosion.

- Conduct field studies and use background information (soils, hydraulics, water level data, etc) to understand effects of water level fluctuations, both natural and anthropogenic, on existing and potential bank instability assuming current and proposed operating scenarios.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The 2012 Integrated List of Waters shows the segment from VT/NH state line to the Turners Falls Dam (MA34-01 and MA34-02) as impaired and considered "*Water Requiring a TMDL*" due to "*Other flow regime alterations*", "*Alteration in stream side or littoral vegetative covers*" and "*PCB in Fish Tissue*". In addition, the segment below the Turners Falls Dam to the confluence with the Deerfield River (MA34-03) is also shown as impaired by these causes as well as total suspended solids. MADEP notes that the requested studies will assist it in issuing a Water Quality Certification that complies with the State and Federal Clean Water Acts.

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[8] The "-2" refers to the stakeholders' study request number.
[9] At the June 14, 2013 study plan meeting, it was noted that the erosion investigation should be expanded to include identifying early stages of potential bank instability. Potential bank instability would include those areas where tension cracks, trees leaning toward the river, or other early stages of potential bank erosion are identified.

<u>Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))</u>

Extensive research has been conducted evaluating the causes and effects of erosion along the Connecticut River in the Turners Falls Impoundment; such research includes:

Connecticut River Joint Commissions and Trails Conservation Assistance Program of the National Park Service through the Connecticut Valley Partnership. (1996) *River Dynamics and Erosion.* Authors.

Field Geology Services. (2004). *Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire.* Farmington, ME: Author.

Field Geology Services. (2007). *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*. Farmington, ME: Author.

Northrop, Devine and Tarbell, Inc.. 1991. *Connecticut River Riverbank Management Master Plan* (Draft). Northeast Utilities Service Company, Inc.

Simons & Associates. (1998). *Erosion Control Plan for Turners Falls Pool of the Connecticut River (Draft).* Western Massachusetts Electric.

Simons & Associates. (1998). *Long Term Riverbank Plan for the Turners Falls Pool of the Connecticut River.* Author.

United States Army Corps of Engineers. (1979). *Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, Vermont.* Author.

United States Army Corps of Engineers. (1991). *General Investigation Study- Connecticut River Streambank Erosion.* Waltham, MA: USACE, New England Division.

Woodlot Alternatives. (2007). *Connecticut River Hydraulic Analysis Vernon Dam to Turners Falls Dam.* Author.

In addition, the following information is available to help inform this study:

- Bathymetric mapping of the Turners Falls Impoundment was completed in 2006.
- On January 22, 2013, FirstLight filed with FERC plan maps showing the location of 22 transects located in the Turners Falls Impoundment. Also provided were cross-section plots of these transects that have been surveyed twice annually since 1998. Note that these transects were selected for two primary purposes (1) they were relatively evenly spaced along the entire impoundment from Vernon Dam to Turners Falls Dam and (2) most were located at sites where erosion was occurring.
- Section 4.2.3 of the PAD contains a discussion of soil types and mapping from Vernon Dam to the Cabot tailrace including the identification of the ten most common soil series found in the Project boundary (PAD Table 4.2.3-1). Soils maps along the riverbanks were included in the

PAD. Included as part of FERC's AIR (see Section 2.0) for the top ten most common soils, FirstLight has included in Appendix C[10] the following other data:

- Relative to soil chemical properties: depth, cation-exchange capacity, effective cation-exchange capacity, and pH.

- Relative to soil physical properties: percent sand, silt, and clay, moist bulk density, saturated hydraulic conductivity, shear and compressive strength, available water capacity, linear extensibility, organic matter and erosion factors (Kw, Kf, and T).

- FirstLight maintains paper copies of their log sheets that include hourly data on flows, water elevations and generation. For the period 2000-2010, FirstLight has converted the paper copies to electronic data. The following data is available that will be used in this study and others:

  - Relative to flows, TransCanada reports the Vernon discharge. Added to this flow are flows from the USGS gages on the Ashuelot and Millers River to estimate total inflow- commonly termed on FirstLight's log sheets as "Naturally Routed Flow". FirstLight also has estimated flows passed through the gatehouse[11] and estimated flows passed over Turners Falls Dam[12].

  - Relative to water levels, FirstLight maintains water level recorders (hereinafter termed "monitors") on the same vertical datum in the Turners Falls Impoundment at the following four locations a) immediately below Vernon Dam, b) directly below the Northfield Mountain tailrace, c) at the boat barrier buoy line approximately 1,500 feet upstream of the Turners Falls Dam and d) at the Turners Falls Dam (see Figure 4.3.1.3-1 in the PAD for locations). For purposes of this study, these four monitors are termed "long-term monitors" and have historically been set to record the WSEL every hour; however, they can be set to record the WSEL more frequently.

- FirstLight also maintained water level monitors on the same vertical datum from approximately May 1 through mid-August in 2012 at two additional locations in the Turners Falls Impoundment --at West Northfield Road (near the VT/NH/MA border) and at the Route 10 Bridge (see Figure 4.3.1.6-1 in PAD for locations). For purposes of this study, these two monitors are termed "short-term monitors".

- Two hydraulic models of the Turners Falls Impoundment are available using the 2006 bathymetry including a steady-state (flow does not vary) one-dimensional HEC-RAS model and a two-dimensional steady-state RIVER2D model.

- Pressure transducers were used to measure water surface elevation (WSEL) fluctuations in the impoundment and groundwater near Bennett Meadow on the west bank just below the Route 10 Bridge. One transducer was placed in the impoundment, and three (52 ft, 65 ft and 210 ft from the river) were placed in monitoring wells along a line perpendicular to the riverbank. The field work

[10] The soil information was obtained from the United States Natural Resources Conservation Service.
[11] Flows through the gatehouse are based on rating curves which relate the magnitude of the gate opening and Turners Falls Impoundment elevation at the dam to the magnitude of discharge.
[12] Flows passed via the bascule gates or tainter gates are based on rating curves which relate the magnitude of the gate position and Turners Falls Impoundment elevation at the dam to the magnitude of discharge.

was conducted from mid-July 1997 through February 1998. These data provide information on the groundwater elevation and hydraulic gradient.

- Hydraulic (near shore velocity), bank material sampling, and suspended sediment sampling was conducted over a range of flow conditions from 1997 through 2011. These data provide information on velocity, hydraulic shear stresses, particle size distributions, and sediment transport.

- Boat wave data was collected on July 12-13, 1997 and July 26-27, 2008. At several locations, temporary staff gages were installed to document wave amplitude and frequency using videotape. Suspended sediment samples were also collected in the area where the waves impacted the shoreline.

- Two reports addressing riverbank erosion were filed with FERC on January 8, 2013 as follows:

    - Simons & Associates. (2012). *Riverbank Erosion Comparison along the Connecticut River*. Prepared for FirstLight. Midway, UT: Author.
    - Simons & Associates. (2013). *Analysis of Erosion in Vicinity of Route 10 Bridge Spanning the Connecticut River*. Prepared for FirstLight. Midway, UT: Author.

- Since late 2012 and through at least 2014, FirstLight is collecting continuous (approximately hourly) suspended sediment concentration (SSC) data at the Route 10 Bridge. After having difficulties with the equipment to measure the SSC from the north and south service mains inside the Northfield Powerhouse (water used for generation and pumping) FirstLight is planning to install SSC monitoring equipment in the Northfield tailrace in 2013.

Project Nexus (18 CFR § 5.11(d)(4))

The Connecticut River in the Turners Falls Impoundment is impacted by three hydroelectric projects which discharge or draw water from the river for hydropower generation. These Projects are (from downstream to upstream): the Turners Falls Project, Northfield Mountain Project, and Vernon Hydroelectric Project. All three Projects can operate as peaking facilities when flows are within the hydraulic capacity of the facilities, which can directly impact water level fluctuations in the Turners Falls Impoundment. When flows exceed the hydraulic capacity of the Vernon and Turners Falls Projects, the projects are operated as a run-of-river projects.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Data Gathering

Extensive research and data gathering efforts have been conducted within the Turners Falls Impoundment over the past several decades which will assist in this study. Existing data includes: hydrology, existing and proposed (see Task 3. below) WSEL monitors, SSC measurements, hydraulic modeling, and previous FRRs. A full list of available data available this study is summarized above- "Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))".

Task 2: Geomorphic Understanding of Connecticut River

It is important to understand the geomorphic setting of the Connecticut River. This task would entail summarizing, as part of a larger report (see report task below), the historic and modern geomorphology of the Connecticut River to provide readers with context. In addition, it would include background on the dynamic nature of alluvial rivers. More specifically, FirstLight will summarize the principal potential causes of riverbank erosion that occur within a river corridor, including natural processes and anthropogenic causes.

Task 3. Install Proposed Water Level Monitors in Turners Falls Impoundment

At the May and June 2013 study plan meetings, stakeholders requested additional water level monitors be placed in the impoundment for two primary purposes (1) to have a better understanding of the rate of change in the water surface elevation WSEL and (2) to have greater coverage throughout the length of the impoundment. FirstLight heard similar concerns on Study No. 3.2.2- *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot*, where additional water level monitors were sought to validate the existing hydraulic model. FirstLight is proposing to install additional monitors as described below (refer to Study No. 3.2.2 for a figure showing the proposed monitoring locations). Table 3.1.2-1 (note that this is the same table appearing in Study No. 3.2.2) lists the proposed[13] and existing water level monitors in the impoundment. Note that between the existing and proposed monitors the location of hydraulic controls in the impoundment will be covered. Thus, although riverbank erosion may be observed at locations other than at the water level monitors, the hydraulic model (as described below) will be used to estimate WSEL at riverbank erosion locations.

Table 3.1.2-1: Proposed and Existing Water Level Monitors in Turners Falls Impoundment

Proposed Location of Water Level Recorder- (see HEC-RAS Transect No.)	Description	Rationale
Turners Falls Dam	Existing Gage: Located at Turners Falls Dam	
Transect No. 486.259: Turners Falls Boat Barrier Line	Existing Gage: Located just upstream of Turners Falls Dam	Located below the French King Gorge
Transect No. 26986.3: Northfield Tailrace	Existing Gage: Located in Northfield tailrace	Located above French King Gorge
Transect No. 30486.3: Located upstream of Northfield Tailrace	Proposed Gage: Located approximately 3,500 feet upstream of the Northfield Tailrace	At the May 14 meeting a question was raised that when Northfield is generating does it create a backwater upstream of the tailrace. This gage is positioned to record changes in the WSEL potentially due to Northfield operation. This gage may provide assistance in Study No. 3.1.2 to evaluate the rate of change in water level fluctuations.
Transect No. 71986.3: Located upstream of a Schell Memorial Bridge	Proposed Gage: Located approximately 8.5 miles upstream of Northfield Tailrace	This location was selected because the river width narrows and could act as a hydraulic control – water levels start to rise at this approximate location based on Figure 3.2.2-2.
Transect No. 92986.3: Located below Stebbins Island	Proposed Gage: Located approximately 5,500 feet below lowermost section of Stebbins Island	This gage would pick up the WSEL just below Stebbins Island.
Transect No. 102986: Located above Stebbins Island	Proposed Gage: Located approximately 2,500 feet	This gage would pick up the WSEL just above Stebbins Island

[13] FirstLight will seek to install the water level monitors as outlined in the table; however, if access is not granted to land, some re-location may be required.

Proposed Location of Water Level Recorder- (see HEC-RAS Transect No.)	Description	Rationale
	above uppermost section of Stebbins Island	
Vernon Tailrace: Located immediately below Powerhouse	Existing Gage	

The proposed and existing[14] water level monitors will be set to record the WSEL every 15 minutes. As noted at the study plan meetings, stakeholders want to understand the rate of change in WSEL, hence the rationale for recording every 15 minutes. FirstLight will install these water level recorders from approximately August 2013 until November 2013 to capture a range of low and high flows and to capture a range of operating conditions at the Vernon, Northfield and Turners' Falls hydropower facilities. The monitors will be surveyed to the same datum as the existing water level recorders. Information from the WSEL monitors will feed into other aspects of this study.

<u>Task 3: Evaluation of Water Elevation and Flow Data</u>

Task 3a. Existing Water Level Monitors- Annual Hydrographs of Turners Falls Impoundment Elevations versus Flow

For each long term monitor, hourly hydrographs (time vs WSEL) of the WSEL will be plotted for each year between 2000 and 2010 on the same figure. The same will be plotted every 15 minutes for each short term monitor on the same figure. Shown on the other y-axis on these plots will be the Vernon discharge, naturally routed flow and flow recorded at the USGS gage in Montague City, MA. The purpose of these plots is to have an understanding of (1) the relationship between the magnitude of streamflow and WSEL fluctuation and (2) the comparative range of daily fluctuation at the four long term monitors.

Task 3b. Existing Water Level Monitors- Evaluation of the Range of Turners Falls Impoundment Elevations on a Monthly (and Annual) Basis

Using the hourly (4 long-term monitors) or 15 minute (2 short-term monitors) WSEL data for the available period of record, a table of the mean, median, maximum and minimum WSEL will be computed on a monthly basis. In addition, monthly (and annual) WSEL duration curves will be developed using the available period of record (already conducted in PAD for the long-term gages). The intent of the analysis is to have an understanding of (1) the range of impoundment elevations on a monthly basis and (2) the comparative difference in the range of impoundment elevation at the 4 long term monitors.

Task 3c. Existing Water Level Monitors- Evaluation of the Maximum Daily Fluctuation of Turners Falls Impoundment Elevations on a Monthly (and Annual) Basis

The magnitude of fluctuation (the difference between the maximum and minimum elevation) occurring on a daily basis in the impoundment will be computed. FirstLight proposes to parse the WSEL data to approximate the range of WSEL fluctuation due to project operations versus those attributable to naturally high flows. The following analysis will be conducted:

[14] FirstLight typically records the WSEL at the existing monitors every hour; however, the monitors can be set to record the WSEL every 15 minutes.

- Using the full period of WSEL data at each monitor (4 long term, 2 short term), compute the minimum and maximum elevation each day. In the case of the long-term monitors the minimum and maximum elevations will be based on the hourly data[15], whereas the short-term monitors will be based on 15-minute data. The maximum and minimum elevation will be subtracted to yield the maximum range of daily fluctuation or "delta" each day. The "delta" will then be used to develop a "delta" duration curve. In sum, this duration curve will show the magnitude of daily fluctuation on a monthly (and annual) basis regardless of the magnitude of flow in the impoundment.

  Per the June 14, 2013 meeting, stakeholders want to understand the range of fluctuation when Northfield was not operating for part of 2010. FirstLight will conduct the same analysis described above for this discrete period of record. This analysis will provide an indication of the range of fluctuation caused by sources other than Northfield.

- FirstLight proposes to conduct the same analysis as above, but would use only those WSELs when water is <u>not</u> discharged at Turners Falls Dam (spill). Note that FirstLight has hourly records of Turners Falls Dam discharges for the same 2000-2010 period of record. The logic for parsing the WSEL data in this fashion is that when spill occurs, FirstLight has no ability to "regulate" the impoundment elevation. In this case, the analysis of WSEL will be focused on those periods when FirstLight can regulate the impoundment elevation.

Task 3d. Proposed Water Level Monitors- Hydrographs of Turners Falls Impoundment Elevations versus Flow

For the proposed water level monitors (and four long-term monitors) 15-minute hydrographs (time vs. WSEL) of the WSEL will be plotted for the period the monitors are installed. Shown on the other y-axis on these plots will be the Vernon discharge, naturally routed flow and flow recorded at the USGS gage in Montague City, MA. The purpose of these plots is to have an understanding of (1) the relationship between the magnitude of streamflow and WSEL fluctuation and (2) the comparative range of daily fluctuation at the proposed and long term monitors.

Task 3e. Proposed Water Level Monitors- Evaluation of the Maximum Daily Fluctuation of Turners Falls Impoundment Elevations

Similar to Task 3c, the delta (difference in minimum and maximum WSEL each day) will be computed for the proposed water level monitors (and four long-term monitors) for the period August through November 2013. Delta duration curves will be developed using the full period of record. Also, similar to Task 3c, delta duration curves will be parsed to include only those periods when Turners Falls Dam is <u>not</u> spilling.

Task 3f. Analysis of Flow and WSEL Data to Correlate Project Operations and WSEL Fluctuations

- Flow data from the Montague City USGS gage and Deerfield River USGS gage (at West Deerfield) will be used to provide context on the magnitude, timing, frequency and duration of flows. Mean daily flows from the Deerfield River gage will be subtracted from the Montague City gage. The resultant flows will be further adjusted by a straight-line drainage area proration to estimate the mean daily flow at Turners Falls Dam. As shown in the PAD, annual and monthly flow duration curves have been developed. FirstLight will develop a mean daily average annual

[15] Historically, FirstLight records the WSEL every hour; no WSEL data is available on a 15-min increment.

hydrograph for the period after several USACE flood control facilities were constructed, to understand the magnitude of flow throughout the year, relative to the hydraulic capacity of the Turners Falls, Northfield and Vernon hydroelectric projects. In addition, using the post-USACE instantaneous peak flow data, a flood frequency analysis (Log Pearson Type III) will be conducted to predict the 2-, 10-, 50- and 100-year flood flows at the Turners Falls Dam. This information will be used for the hydraulic modeling assessment as described below.

- FirstLight records on an hourly basis the Vernon Dam discharge, inflows from the Ashuelot and Millers Rivers, Turners Falls "spill" and gatehouse discharge. The magnitude of generation or pumping (MW) at the Northfield Mountain Project can be converted to flow based on a MW versus cfs curve. Thus, all of the flow inputs (Vernon, tributaries, Northfield generation) and outputs (Northfield pumping, gatehouse discharge, dam spill) to the impoundment are available. For the period the proposed monitors (and 4 long term monitors) are operable in 2013, various plots will be developed to help correlate project operations and naturally high flows with WSELs. Numerous hourly hydrographs showing flow inputs and outputs to the impoundment, along with WSEL monitoring data will be used to help correlate WSEL fluctuations with project operations and naturally high flows.

  Note that although the water level monitors will be in place for a portion of 2013, they will likely not "record" all possible combinations of flows and Project (Vernon, Northfield, Turners Falls) operations. To evaluate various flows and Project operational conditions that are not "recorded" with the water level monitors, the hydraulic model (described next) will be used.

Task 4: Hydraulic Model of Turners Falls Impoundment

Steady state one dimensional (HEC-RAS) and two dimensional (RIVER2D) hydraulic models exist for the Turners Fall Impoundment. These models are based on bathymetry collected in 2006. Study No. 3.2.2 *Hydraulic Study of Turners Fall Impoundment, Bypass Reach and below Cabot Station*, describes the HEC-RAS hydraulic modeling proposed for the impoundment. As described in Study No. 3.2.2, the HEC-RAS hydraulic model will be calibrated and validated to observed WSELs from past and proposed water level monitoring data collected within the impoundment. Note that the water level monitoring data may not reflect the full range of the FERC licensed water level fluctuation for the impoundment, which extends from elevation 185 feet msl to 176 feet msl. The hydraulic model, once calibrated/validated, will be used to simulate the full range of operating conditions that may not be observed with the water level monitors. The intent of the analysis is to determine how project operations directly impacts WSELs in the impoundment

The hydraulic model will also be used to simulate a range of flows and different downstream boundary conditions. In this case, the downstream boundary conditions reflect the impoundment elevation at Turners Falls Dam. Thus, the downstream boundary condition will be set to any elevation between 176 feet msl and 185 feet msl. Analyses will be conducted to determine the flow at which hydraulic control of the impoundment shifts from the Turners Falls Dam to other hydraulic controls, such as the French King gorge[16].

[16]On February 22, 2013 FERC filed hydraulic modeling results of the Turners Falls Impoundment which showed that hydraulic control of the river shifts to the French King Gorge at a flow of approximately 30,000 cfs. This analysis will be re-confirmed after the model is calibrated and validated to the existing and proposed water level monitors.

Once the hydraulic model is calibrated and verified it will be used to predict the minimum, maximum and normal impoundment levels, Ordinary High Water Mark (OHWM), and min/max daily ranges at those locations where erosion exists or has the potential to exist. Note that water level monitors will not be placed at all locations where erosion exists or has the potential to exist. At these locations, the hydraulic model will be used to predict the range of WSEL fluctuations attributable to project operations and naturally high flows. In short, the hydraulic model will not fully replace field-based physical measurements but it can be used to fill in gaps in the geographic distribution of water level monitors as well as extend hydraulic data to cover the full range of current FERC licensed operating conditions that may not be captured by field data collection..

In addition to the HEC-RAS model, the RIVER2D model yields information on the relationship between flow and near-bank velocity. Both HEC-RAS and RIVER2D modeling will be used to analyze near-bank velocity to determine shear stress along the bed and riverbanks. RIVER2D computes velocity vectors showing the magnitude and direction of velocity across the channel at each node representing the channel geometry. Of particular interest are the velocity vectors in the near-bank region where the flow of water directly affects the bank. At specifically selected locations for detailed study, the velocity vectors will be determined over a range of flow conditions. The near-bank velocity will be used to compute hydraulic forces in the vicinity of the riverbanks in lieu of a general shear stress calculation acting across the entire width of the river. Results of RIVER2D will allow the analysis to focus on the region of the flow next to the banks where flowing water exerts hydraulic forces that directly affect the riverbanks.

As noted in the study plan meetings, stakeholders want to understand the rate of change in the WSEL over time. Although the rate of change will be collected at the proposed and existing water level monitors, it will not cover all of the locations of existing erosion and potential bank instability. At these locations, the HEC-RAS hydraulic model will used in an unsteady model (flow varies with time) to predict the rate of WSEL change at existing erosion and potential bank instability locations. For example, a 15-minute time varying flow hydrograph will be routed through the impoundment and the corresponding WSEL at a given location will be predicted.

Task 5: Field Study

The geographic extent of the field based study was discussed at the June 14 meeting. FirstLight agreed to extend the field work to include the riverbanks and islands located from Turners Falls Dam to Vernon Dam, except for those areas where bedrock, bridge crossings and rip rap is located.

Task 5a. Background Mapping

Prior to conducting any field work, geo-referenced aerial imagery of the Turners Falls Impoundment will be developed in GIS and uploaded to pentop computer so that the geographic extents of active or recent bank erosion or potential bank instability can be noted directly in the field. Also, separate GIS layers showing soil mapping and land use classification will be loaded along with the aerial imagery to allow personnel conducting the field assessment with quick reference data.

Task 5b. Field Evaluation- Round 1

As an integral part of both relicensing and compliance, a full river reconnaissance (FRR) described in Study No. 3.1.1 will be conducted in the fall 2013. This study includes a boat-based mapping component to delineate riverbank features and characteristics along the Turners Falls Impoundment as well as a land-based component to document erosion features and potential bank instability by walking[17] the length of the impoundment and islands (except for impassable sections such as French King Gorge and potentially other small segments associated with bridges, other structures or bedrock areas). The field work will be conducted by a geotechnical engineer and fluvial geomorphologist/hydraulic engineer. The data recorded for this field work is described in greater detail in study No. 3.1.1. The field work will be evaluated prior to the Round 2 field work as described below.

Note that land use practices near the riverbank will be noted during the on-the-ground survey work. In some instances land use practices have directly impacted upper bank stability due to poor land management practices. For example, in some locations cattle have been observed grazing the riverbank down to the river's edge.

Task 5c. Evaluation of Round 1 Field Evaluation

The selection of sites for detailed study will initially examine the range of riverbank features and characteristics from the 2013 FRR compared to the range of features and characteristics at the existing 22 transects. Because riverbank features and characteristics are not highly varied in the impoundment, FirstLight will select fixed recoverable transects to be representative of the range of features/characteristics. FirstLight will utilize the existing 22 transects so long as they are representative of the range of riverbank features and characteristics. If they are not, then a list of additional fixed recoverable transects will be developed for detailed study. It is also possible that the existing 22 transects are duplicative and consist of a number of sites that are very similar in terms of features and characteristics. The combination of the selection from the 22 transects and the list of additional fixed recoverable transect will be the final sites where detailed studies are to be conducted. The total number of sites where detailed studies will be conducted may be more or less than 22 but will be selected to ensure coverage of a range of riverbank features and characteristics useful in developing an understanding of erosion processes as well as stability. Specific components of the detailed analysis (i.e., boat wave, geotechnical, hydraulic shear) may all be conducted at some of the selected sites or some sites may be specifically selected for a specific type of analysis only so that not all components of the detailed analysis will be conducted at all of the sites selected for detailed study.

At the fixed recoverable transects representing the range of riverbank features and characteristics, an in-house evaluation will be conducted before the Round 2 field evaluation is conducted. The following will be assessed at the transects prior to the second field visit:

- Analyze soils (classification, structure, parent materials, texture, hydric regime, position on landscape, chemistry, and most importantly engineering dynamics such as susceptibility to slope failure). Determine if there are similar soil characteristics at the current erosion or potential bank instability locations.
- Using the hydraulic model, predict the WSEL at each location under a variety of conditions – different downstream boundary conditions at Turners Falls Dam (ranging from 176 to 185 feet msl, the FERC licensed range), different magnitudes of flow, and different Project (Vernon, Northfield, Turners Falls) operating conditions. The purpose of this analysis is to evaluate the range of fluctuation due to various anthropogenic and natural causes. The model will also be used to estimate near-bank shear stress. It will be important to understand at each fixed recoverable transect the range water level fluctuation due to Project (Vernon, Northfield, Turners Falls) operation and naturally high flows.

[17] Some of the upland areas are privately owned. FirstLight will seek permission to access these lands, but if not permitted, no land based work will be conducted.

Task 5d. Field Evaluation- Round 2

Based on the Round 1 field work (FRR) and in-house evaluation, the geotechnical engineer and fluvial geomorphologist/hydraulic engineer will conduct a second site visit to the fixed recoverable transects for detailed data collection and analysis The fixed recoverable transects will be surveyed and endpoints monumented to allow for future survey and direct comparison of geomorphic changes at the transects. At the fixed recoverable transects the slope instability and erosion will be assessed. Based on a visual assessment the bank soil characteristics will verified with the soils mapping conducted in Task 5c. A photographic log of the transects will be obtained.

In addition, at the fixed recoverable transects a sensitive receptors overlay will be mapped. The sensitive receptors could include habitat for bank-nesting birds, rare species occurrences, vegetated shallows and other sensitive factors such as archeological sites. A sensitive receptors overlay may not preclude future stabilization, but it will be taken into account when compared to similar habitat availability in the impoundment.

Task 6: Causes of Erosion

Once the Round 2 field work is completed, the geotechnical engineer and fluvial geomorphologist/ hydraulic engineer will evaluate field data to analyze conditions of slope instability and erosion. This analysis will focus on slope conditions, relative susceptibility of bank failure due to the various factors including all significant hydraulic and geotechnical related causes that either increase forces acting on the riverbanks or decrease forces resisting erosion including: flow events, water level fluctuations and repeated wetting and drying, boat wakes, land-use activities, seepage and piping, or any other significant cause. The analysis will utilize bank and channel geometry data, soils data, vegetation data, as well as hydraulics to understand the erosion and mass-wasting processes from a fluvial hydraulics and geomorphic perspective as well as from a geotechnical perspective. The contribution of the various causes of erosion will be quantified and ranked so that a better understanding of these processes will be developed.

The fluvial geomorphologist/hydraulic engineer and geotechnical engineer will collectively evaluate the cause or causes of riverbank erosion throughout the Turners Falls Impoundment generally and at each fixed recoverable transect. Causes of erosion throughout the study area could be due to a single source or combination of sources. Potential causes of erosion could include:

- Hydraulic shear stress due to flowing water;
- Water level fluctuations due to hydropower operations;
- Boat and wind waves;
- Land management practices;
- Seepage and piping;
- Freeze-thaw;
- Ice or debris;
- Animals such as nesting burrows; and
- Anthropogenic influences to the riparian zone (e.g., removal of riparian vegetation, cattle grazing to the river's edge, heavily traveled recreation trails)

The hydraulic model will be used to provide context on the relationship between flow, water level, velocity; and how these vary through the impoundment and as a result of various modes of operation.

In order to develop the necessary understanding of the various causes of erosion and the forces associated with them, and their relative importance at a particular location, the following analyses will be conducted. These analyses and associated data collection will focus primarily at the selected sites for detailed study.

Hydraulic Shear Stress due to Flowing Water (Tractive Force)

With the available information and data, analysis will focus on forces that cause erosion, forces that resist erosion, observations of erosion, the elevation range over which the forces act on the riverbanks, and the duration of time that the various forces act on riverbanks in the impoundment. According to *"Sediment Transport Technology, Water and Sediment Dynamics"* (Simons, D.B. and F. Senturk, 1992):

> *"An alluvial river generally is continually changing its position and shape as a consequence of hydraulic forces acting on its bed and banks and related biological forces interacting with these physical forces. . . Until sufficient forces are exerted on the boundary of alluvial channels, the particles comprising the boundary remain stationary and the system behaves as a rigid channel. However, once the critical shear stress has been exceeded for the size of particle comprising the channel boundary, initiation of motion begins."*

When erosive forces exceed resisting forces, an imbalance of forces exists resulting in potential erosion. Erosion may occur due to particle by particle transport or by mass-wasting when blocks of sediment, typically due to gravitational forces, break loose and move vertically down the slope. Such blocks of sediment may remain relatively intact or may break apart and can then be further eroded and transported in a particle by particle mode.

Shear stresses due to the tractive force of flowing water are calculated as a function of the velocity of flow and compared to critical shear stress based on particle size using the Shield's relationship as explained in numerous texts such as the previously referenced Sediment Transport Technology and *"River Engineering for Highway Encroachments, Highways in the River Environment,"* (Hydraulic Design Series Number 6, Publication No. FHWA NHI 01-004, 2001, E.V. Richardson, D.B. Simons and P.F. Lagasse). Hydrodynamic forces due to water level fluctuations will account for the rate of change of water level over time and the range of the overall fluctuations. The rate of change in water level in the soil matrix will also be factored into the analysis of overall forces resulting from the water level changes in the river itself using the rates of water movement related to seepage.

In order to analyze the hydraulic shear stress related to erosion associated with this phenomenon, samples of sediment from the riverbanks will be collected and analyzed to determine particle size distribution. This will be done using a sieve analysis in the laboratory. Shear stress exerted by flowing water will be calculated based on near-bank velocities using the Shield's criteria. Shield's criteria relates velocity to the particle size of sediment at the point of incipient motion; in other words, it is utilized to compute the size of sediment that begins to be eroded and transported as a function of velocity or shear stress. Velocities will be measured at selected sites over a range of flow conditions. The velocity information will be extended to a wider range of flow conditions based on the results of hydraulic modeling (HEC-RAS and RIVER2D). Suspended sediment samples will also be collected over a range of flows to develop a relationship between sediment transport and hydraulic conditions. Sediment concentrations are an indicator of stability and lack of erosion, in the case of low concentrations; and high concentrations are an indicator of erosion and sediment transport. The relationship between hydraulic conditions and suspended sediment concentration and transport will be utilized to understand the flow- related conditions that are associated with erosion.

Boat Waves

Evaluation of hydrodynamic forces due to boat waves will utilize both the horizontal and vertical velocity of water movement as well as energy and tractive force approaches compared to the energy of the streamflow itself. Data will consist of the amplitude, frequency and speed of boat waves and the observed effects of waves on the riverbank using staff gages, video, and measurement of effects. At selected locations (a sub-set of the sites selected for detailed study and establishment of permanently marked cross-sections), boat wave related erosion data will be collected. A staff gage will be placed in the riverbank so the amplitude of waves can be measured. The riverbank area in the vicinity of the staff gage will be videotaped to document the rate of rise and fall of the water level and the frequency of waves. Boat traffic information will be documented at the time of the field work and supplemented by boat traffic data from the recreation study. Erosion associated with boat waves will be documented photographically and through measurements of the amount of erosion. Near-bank suspended sediment samples will be collected to document localized effects of this type of erosion.

Two studies will be utilized as a basis for conducting this evaluation regarding techniques to compare wave energy to the energy or stress caused by flowing water: *"Hydrodynamic Impacts of Commercial Jet-Boating on the Chilkat River, Alaska,"* (D.F. Hill, M.M. Beachler, P.A. Johnson Department of Civil & Environmental Engineering, The Pennsylvania State University, 2002) and *"Boat-Wave-Induced Bank Erosion on the Kenai River, Alaska,"* (Stephen T. Maynord, David S. Biedenharn, Craig J. Fischenich, and Jon E. Zufelt, 2008, Engineer Research and Development Center, USACE). These studies developed and applied an approach to compare the energy from boat waves to the energy of streamflow. Analysis will compare the rate of change of boat waves to changes due to other factors and effects on the riverbanks. An energy comparison will be utilized to analyze and evaluate the effect of boat waves along with observation of wave dynamics and erosion as observed in the Turners Falls Impoundment.

Geotechnical analysis of hydrodynamics of flow and water level fluctuations

An approach to develop a combined understanding of fluvial and geotechnical processes regarding riverbank erosion is the Bank-Stability and Toe-Erosion Model (BSTEM) developed by the USDA-ARS, National Sedimentation Laboratory. This approach was described as follows:

> *BSTEM evaluates the force-equilibrium factor of safety of either planar- or cantilever-shear failure in a layered streambank. The resisting forces comprise the cohesive and frictional strengths of the soil, forces due to positive and negative porewater pressures and a component of the hydrostatic confining force afforded by water in the channel. The driving forces comprise the weight of the failure block reduced by a component of the hydrostatic confining force. A global search algorithm was employed to search for the minimum factor of safety. An advanced root-reinforcement model based on fiber-bundle theory was applied to quantify the increase in bank strength due to assemblages of riparian vegetation. The hydraulic-erosion component of BSTEM estimates the applied shear stress along the bank toe and bank face and to erode these surfaces perpendicular to the existing geometry.*

BSTEM was developed by the National Sedimentation Laboratory (*"Iterative Bank-Stability and Toe-Erosion Modeling for Predicting Streambank Loading Rates and Potential Load Reductions,"* 2010, Andrew Simon, Research Geologist, USDA-ARS, National Sedimentation Laboratory, Oxford, MS, Natasha Bankhead, Research Geologist, USDA-ARS, National Sedimentation Laboratory, Oxford, MS, and Robert Thomas, Research Associate, Department of Civil and Environmental Engineering, University of Tennessee, Knoxville, TN). This approach, as well as other traditional geotechnical analysis tools, will be utilized in the analysis of riverbank stability in the Turners Falls Impoundment.

Input data for BSTEM includes channel geometry data, bank layer thickness, bank material characteristics (particle size, friction angle, cohesion, saturated unit weight, ϕ^b (angle representing the relation between the shear strength and matric suction), critical shear, erodibility coefficient), and flow characteristics over time (slope, depth, duration), and ground water table depth. Data will be collected in the field at the locations for detailed study to characterize and quantify riverbank soils/sediments regarding geotechnical properties (the sites selected for this aspect of the detailed analysis may be a subset of the overall number of sites selected for detailed analysis). This will include three types of data collection: 1) bore hole shear test using a hand auger to conduct a direct, in-situ shear test and cohesive properties of the apparent effective friction angle, 2) bulk density of the soil, and 3) determination of erodibility coefficient using a submerged jet test. Sediment samples for particle size distribution will also be collected and analyzed related to critical shear analysis using Shield's criteria. These data will be collected for the various layers of soil found at the selected sites. The model also includes vegetation characteristics and the effect of vegetation on the erosion process as well as tension cracks and positive and negative pore water pressures. Data collection will also include information on vegetation, root structure and density so that the vegetation component of the model can be effectively utilized. The model computes factor of safety as it varies over the hydrograph, bank failure width and volumes, sediment loading, and changes in bank geometry due to mass-wasting and erosion over time.

Spatial Analysis

Some causes of erosion cannot be readily related to forces, but instead can be evaluated spatially. For example, the riparian vegetation zone has been altered by land clearing which affects riverbank stability. This and other effects that are localized to specific reaches of the impoundment will be analyzed based on the length of where such phenomena have affected the riverbanks of the impoundment using available aerial photography and the results of the 2013 FRR.

Comparison and Evaluation of Erosion Processes

The 1979 study conducted by the U.S. Army Corps of Engineers ("*Connecticut River Streambank Erosion Study, Massachusetts, New Hampshire and Vermont*") analyzed riverbank erosion utilizing a tractive force or shear stress approach whereby the various causes of erosion were evaluated by comparing them to the tractive force due to the flow. The USACE report states:

> *"The tractive force method described by Chow (1959) was utilized by the New England Division of the U.S. Army Corps of Engineers to evaluate bank erosion on the Connecticut River. This method is basically sound and has been widely used to design and evaluate the stability of alluvial channels."*

The relative magnitude of forces associated with the various causes of erosion as well as the length of time or duration over which the forces act were developed into a matrix to evaluate the causes of erosion. *"The relative magnitude (M_B) and relative duration (D_B) of the forces causing bank erosion for non-cohesive and stratified bank materials have been assessed qualitatively."* In addition to evaluation of the magnitude and duration of forces, the study also considered the portion of the riverbank where the various forces attacked the bank:

> *"In order to more clearly focus on the major causes of bank erosion, it is perhaps worthwhile to subdivide these forces in relationship to where they act. Many geologists, engineers and laymen alike miss the main point when they consider major causes of bank erosion. One must consider that the forces acting on the bank can be broken into two categories: (1) those forces that act at or near the surface of the water associated with pool fluctuations, related piping, groundwater, wind waves, boat waves, ice, lack of or*

> *removal of vegetation, and so forth, and (2) those forces acting on the full height of the submerged bank."*

The study then discussed the vertical distribution of tractive forces acting on the riverbank associated with flowing water which acts over the entire submerged bank face, but with greatest forces acting about two-thirds of the depth below the water surface. The 1979 USACE study is similar to, and provides a basis for, the sediment transport study that is proposed to be conducted on the Turners Falls Impoundment. The fluvial geomorphologist/hydraulic engineer and geotechnical engineer will collectively look at all of the available data gathered above (plasticity index, particle size distributions, soils shear and compressive strength, soils maps, water level data, flow velocity data, hydraulic modeling, suspended sediment sampling, etc.); as well as apply analysis methodologies as described above to make the determination as to whether the slope instability and/or erosion is caused (in whole or in combination with other factors) by hydropower operations. The analysis will include quantifying forces associated with the various causes of erosion; accounting for ranges, rates and frequency of flow and water level fluctuations; durations of flow and water levels; and consideration of where on the riverbank the various forces act.

Task 7: Report

A comprehensive report will be developed. It is anticipated the final report will include the following sections:

- Executive Summary
- Introduction
- Geomorphology of the Connecticut River
- Soils and Surficial Geology Mapping
- Analysis of Water Level and Flow Data
- Hydraulic Modeling
- Selection of sites and site-specific data collection
- Analysis of Causes of Erosion
- Evaluation and Discussion of Analysis Results

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is between approximately $400,000 and $500,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The cover letter outlines the PSP meeting schedule. The purpose of the Study Plan Meeting will be to resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. A portion of the field work may be conducted in 2013 along with the FRR. However, it is likely that the bulk of this study will be conducted during 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.2 Water Resources

3.2.1 Water Quality Monitoring Study

General Description of Proposed Study

Several stakeholder groups submitted water quality study requests to FirstLight. Water quality monitoring requests were received from MADEP, USFWS, CRWC, FRCOG, Town of Gill, LCCLC, VANR and NHDES.

The MADEP, USFWS, and CRWC study requests were similar and requested that the applicant conduct a water quality survey of the Turners Falls Impoundment, bypass reach, power canal, and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). MADEP, USFWS, and CRWC request that FirstLight collect continuous water temperature and dissolved oxygen (DO) data including biweekly DO and temperature profiles in the Connecticut River from April 1 through November 15, and monthly DO and temperature profiles within the upper reservoir from June through September. FirstLight is proposing continuous temperature and DO sampling, along with biweekly vertical profiles within the Connecticut River. As an alternative to periodic profile sampling in the upper reservoir, FirstLight proposes to monitor water temperature and dissolved oxygen in the Northfield Mountain Project discharge. These methods will be consistent with and therefore comparable to continuous data collected upstream and downstream of the tailrace, and can directly assess the impact of the discharge on water temperature and dissolved oxygen in the Connecticut River.

MADEP, USFWS, and CRWC also requested that impoundment sediment adjacent to the Turners Falls Dam should be analyzed for metals and polychlorinated biphenyls (PCBs). As described in the existing information, benthic sediment was sampled in the Turners Falls Impoundment and upper reservoir in August 2010 as part of the USEPA consent order to inform FirstLight's dredging operations. The samples were analyzed for metals, organics, pesticides, and PCBs, and the results were compared to MADEP regulatory standards. FirstLight is not proposing to conduct sediment sampling as part of this study.

Town of Gill, FRCOG, and LCCLC submitted similar requests for a water quality study, and included a request for monthly samples of total suspended solids and turbidity within the upper reservoir. FirstLight is not proposing to add turbidity or TSS to the water quality study plan because suspended sediment data are already being collected under FirstLight's *Sediment Management Plan* as described under Study No. 3.1.2 (see existing information section).

VANR and NHDES requested a more focused water quality study to determine if project operations are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards. Their request for continuous data was linked to low flow periods and included additional parameters such as nutrients and chlorophyll a. FirstLight has proposed a sampling location in the Connecticut River upstream of the Massachusetts border which would be representative of inflow conditions to the Project. Sample parameters at this location will include temperature and DO, consistent with the sampling locations throughout the remainder of the Project study area. FirstLight is not proposing to collect data on nutrient parameters in the Connecticut River upstream of the Massachusetts border because these parameters are not consistent with MADEP's request and would not provide useful information if collected from a limited area.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The objectives of this study are to:

- Characterize water temperature and DO within the Turners Falls Impoundment, bypass channel, power canal, and below Cabot Station.
- Determine potential impacts of the Turners Falls Project and Northfield Mountain Project on water temperature and DO.
- Compare collected data with applicable state water quality standards.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The MADEP is responsible for issuing a water quality certification to FirstLight for the continued operation of the projects under Section 401 of the Clean Water Act. The MADEP has designated the Connecticut River as a Class B river for its entire length in Massachusetts, and the river is assigned the designated uses of habitat for fish, other aquatic life and wildlife, and primary and secondary contact recreation, 314 CMR 4.05(3)(b). The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses.

The USFWS water quality goals are to: 1) Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats; and 2) Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Part of the project area is within New Hampshire, and the NHDES establishes and administers surface water quality standards for New Hampshire; the Connecticut River within the New Hampshire portion of the project area is Class B water. The NHDES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained. The Connecticut River is also classified by the state of Vermont as Class B cold water fish habitat, which should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat, although criteria for Vermont are, in some cases, different than New Hampshire.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Water Quality Data and Reports

A multitude of federal, state and local organizations have studied the water quality of the Connecticut River in the vicinity of the Projects, including the following:

Carr, J. W. & Kennedy, L. E. (2008). *Connecticut River watershed 2003 water quality assessment report* (Rep. No. 34-AC-2). Worcester, MA: Massachusetts Department of Environmental Protection, Division of Watershed Management.

Connecticut River Joint Commissions (CRJC). (2009). *Connecticut River management plan – Wantastiquet region.* Charlestown, NH: Author.

Deacon, J., Smith, T., Johnston, C., Moore, R., Weidman, R., & Blake, L. (2006). *Assessment of total nitrogen in the Upper Connecticut River basin in New Hampshire, Vermont, and Massachusetts, December 2002-September 2005* (Scientific Investigations Report 2006-5144). Reston, VA: US Geological Survey.

Donlon, Andrea. (2008). *Volunteer water quality monitoring program annual report 2007*. Greenfield, MA: Connecticut River Watershed Council.

Donlon, Andrea. (2009). *Volunteer water quality monitoring program annual report 2008*. Greenfield, MA: Connecticut River Watershed Council.

Hellyer, Greg. (2006). Connecticut River fish tissue contaminant study 2000 – Ecological and human health risk screening. North Chelmsford, MA: US Environmental Protection Agency, New England Regional Laboratory. Retrieved from: http://www.epa.gov/region1/lab/reportsdocuments/ctriverftr2000/

Hickey, K. & Shanahan, P. (2012). *Review of Vermont Yankee Thermal Discharge Permit Requirements and Analysis of Connecticut River Water Temperature and Flow*. Acton, MA: HydroAnalysis.

Matusky & Skelly Engineers. (1993). *Hydrodynamic and thermal modeling studies*. Berlin, CT: Northeast Utilities Services Company.

US Fish and Wildlife Service, Personal Communication, Ken Sprankle. Raw data of temperature monitoring in the Turners Falls Impoundment in 2010.

Need for Additional Water Quality Data

The state and federal resource agencies have requested a study of current water quality of the Connecticut River within the Project area. The results of the study should provide information sufficient to enable agencies to understand water quality conditions at the Project.

Sediment Contaminant Data

The resource agencies have requested that impoundment sediment adjacent to the Turners Falls Dam be analyzed for metals and PCBs. FirstLight believes that recently collected data from the Turners Falls Impoundment contains sufficient data to address this issue.

Sediment was sampled in the Turners Falls Impoundment and upper reservoir in August 2010 as part of the USEPA consent order to inform FirstLight's dredging operations. The samples were analyzed for metals, organics, pesticides, and PCBs and the results were compared to MADEP regulatory standards. No PCBs or pesticides were detected in any of the samples. Naturally occurring metals were detected in all of the samples at levels below the residential soil standards, with the exception of nickel. The concentration of nickel in some samples modestly exceeded the residential soil standards, but on average the nickel concentrations were below the residential soil standards. MADEP is currently seeking input on raising the regulatory standard for nickel. If the new standard being proposed by MADEP were to be passed, nickel concentrations in the tested sediments would be well below the new standard. In any event, it appears the nickel is naturally occurring and unrelated to project operations. If requested, the sediment sampling data will be made available.

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and Northfield Mountain Pumped Storage Project may directly impact water quality through the use of water for hydropower generation.

The investigation area includes the following:

- The 20-mile Turners Falls Impoundment from the Project Boundary to the Turners Falls Dam.
- The Northfield Mountain Project Tailrace.
- The 2.7 mile long bypass from the Turners Falls Dam to the confluence with Cabot Station.
- The Turners Falls Power Canal.
- The Connecticut River downstream of Cabot Station.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

As recommended by the MADEP, water temperature and dissolved oxygen will be assessed in relation to project operations from spring through fall. If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year) then a second year of data collection may be necessary. Two types of sampling will be performed: 1) continuous temperature and DO monitoring, and 2) periodic vertical profiles of temperature and DO.

Task 1: Develop Sampling Plan

MADEP states that a proposed water quality sampling plan is to be submitted to MADEP for approval prior to sampling and should be developed in consultation with MADEP and USFWS. Once the FERC Study Plan Determination is issued, which would detail the elements of the water quality study, FirstLight will prepare a detailed sampling plan consistent with FERC's determination for review and approval by MADEP. The sampling plan will include quality assurances procedures to be followed during the study execution.

Task 2: Dissolved Oxygen and Temperature Monitoring

Temperature and DO will be recorded every 15 minutes using *in situ* water quality meters at nine proposed locations within the project area (Table 3.2.1-1) during the periods described below. The sampling locations are shown in Figure 3.2.1-1, Figure 3.2.1-2, and Figure 3.2.1-3. Water temperature will be collected from April 1 through November 15. DO measurements will be collected from the same locations during the summer low flow, high temperature period, June 1 through September 30. Meters installed in impounded waters will be suspended from surface buoys and deployed to 25% of the depth of the sampling location. In the bypass reach, canal, and downstream sampling locations, the meters will be installed mid-channel, mid-depth, as practical.

Spot measurements of DO and temperature will be taken during deployment, bi-weekly site visits, and upon retrieval to verify meter accuracy. Weather and flow[18] conditions will be noted.

The water quality meters will be visited approximately once every other week, at which time data will be downloaded, the meter checked for calibration, and then re-deployed. The meter locations will be geo-referenced using GPS.

Task 3: DO and Temperature Profiles

To examine the vertical trends in temperature and DO within the Turners Falls Impoundment, bi-weekly vertical profiles of temperature and DO concentration will be recorded at three locations as shown in Figure 3.2.1-4 and described as follows: 1) the deepest location within the impoundment located downstream of the French King Gorge, 2) a relatively deep area of the impoundment upstream of the Northfield Mountain tailrace, a 3) a relatively deep area of the impoundment downstream of the Northfield Mountain tailrace (at the boat barrier). Bathymetric data indicate that the deepest location is approximately 125 feet deep.

Starting at the surface, measurements of temperature and DO will be collected at 1.0 meter depth increments[19]; the depth of a thermocline or chemocline (DO) will be recorded. Vertical profiles will be collected approximately once every other week starting in early April 2014 through mid November 2014, for a total of approximately 16 profiles, concurrent with Task 2.

Task 4: Report

A report will be prepared describing the monitoring methods and the results. An assessment of the potential effects of Turners Falls Project and Northfield Mountain Project operations on water quality will be discussed. For this assessment, FirstLight will provide hourly operations data during the duration of the continuous DO and temperature monitoring, including:

- Turners Falls Impoundment elevations as measured at the Vernon Tailrace, Northfield Mountain Tailrace, and Turners Falls Dam;
- Periods when Northfield Mountain is pumping, generating, or idle;
- Periods when Cabot Station and Station No. 1 are generating or idle;
- Discharges from Turners Falls Dam (spill), and;
- "Natural Routed Flow" through the Turners Falls Impoundment (estimate of flow at Turners Falls Dam).

The report will be submitted as part of the Initial Study Report as per the ILP process schedule. A tentative table of contents for the water quality report follows:

- Introduction
- Project Operations
- Hydrology and Weather Conditions
- Water Quality Monitoring Methods

[18] Flow conditions in the Turners Falls Impoundment will be based on the estimated discharge from the Vernon Hydroelectric Project, intervening inflow from the Ashuelot and Millers River USGS gages, estimated discharge over the Turners Falls Dam, and the Connecticut River at Montague USGS gage.

[19] Because Station No. 6 is extremely deep, the vertical profile measurement intervals will be collected every 1.0 meter starting at the surface, until a homothermous condition is encountered in the hypolimnion.

- Water Quality Monitoring Results
- Discussion/Conclusions

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Projects on water quality in the Project area. The estimated cost for this one-year study is between approximately $70,000 and $90,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

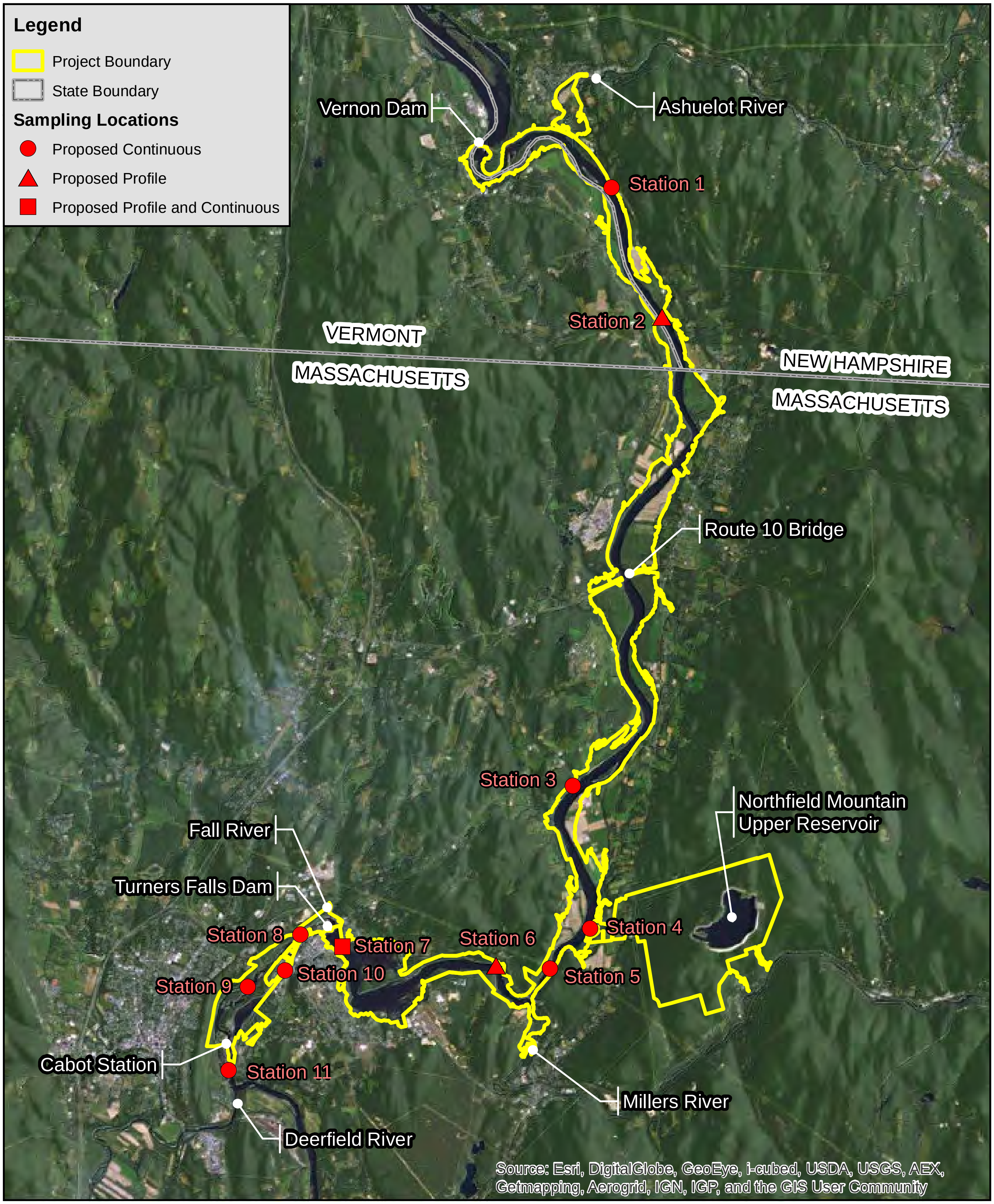
In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

A draft sampling plan developed under Task 1 will be provided to MADEP and USFWS in late 2013 once the FERC Study Plan Determination is issued. The sampling plan will provide more detail on the scope of work approved in the Study Plan Determination. Field work for this study is planned to occur from April through November 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Table 3.2.1-1: Proposed Water Quality Sampling Locations

Station No.	Type	Location	Comments
		Connecticut River- Turners Falls Impoundment	
1	Continuous	Below the Vernon Dam and Ashuelot River Confluence	Near thalweg at 25% depth
2	Profile	Deep area upstream of Northfield Mountain	Collect profile at one meter depth increments
3	Continuous	Above the Northfield Mountain Discharge; Downstream of Kidds Island	Near thalweg at 25% depth
4	Continuous	Northfield Mountain Tailrace	Within the Northfield Mountain Tailrace at 25% depth
5	Continuous	Below the Northfield Mountain Tailrace; Upstream of Millers River Confluence	Near thalweg at 25% depth
6	Profile	Deepest area of Turners Falls Impoundment	Collect profile at one meter depth increments until homothermous hypolimnion is encountered
7	Profile and Continuous	Upstream of the Turners Falls Dam at Boat Barrier	Collect profile at one meter depth increments and install continuous meter at 25% depth
		Connecticut River- Bypass Reach	
8	Continuous	Upstream of Station No. 1	Mid-channel, mid-depth
9	Continuous	Within pool upstream of Rock Dam; downstream of Station No. 1	Mid-channel, mid-depth
		Turners Falls Power Canal	
10	Continuous	At the 11th Street Bridge	Mid-channel, mid-depth
		Connecticut River- Below Cabot Station	
11	Continuous	Below the Cabot Station tailrace, upstream of Deerfield River confluence	Thalweg, mid-depth.



FirstLight Power Resources
GDF SUEZ

FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

N

0 1 2 4 Miles

Figure 3.2.1-1
Overview of Proposed Water Quality Sampling Locations

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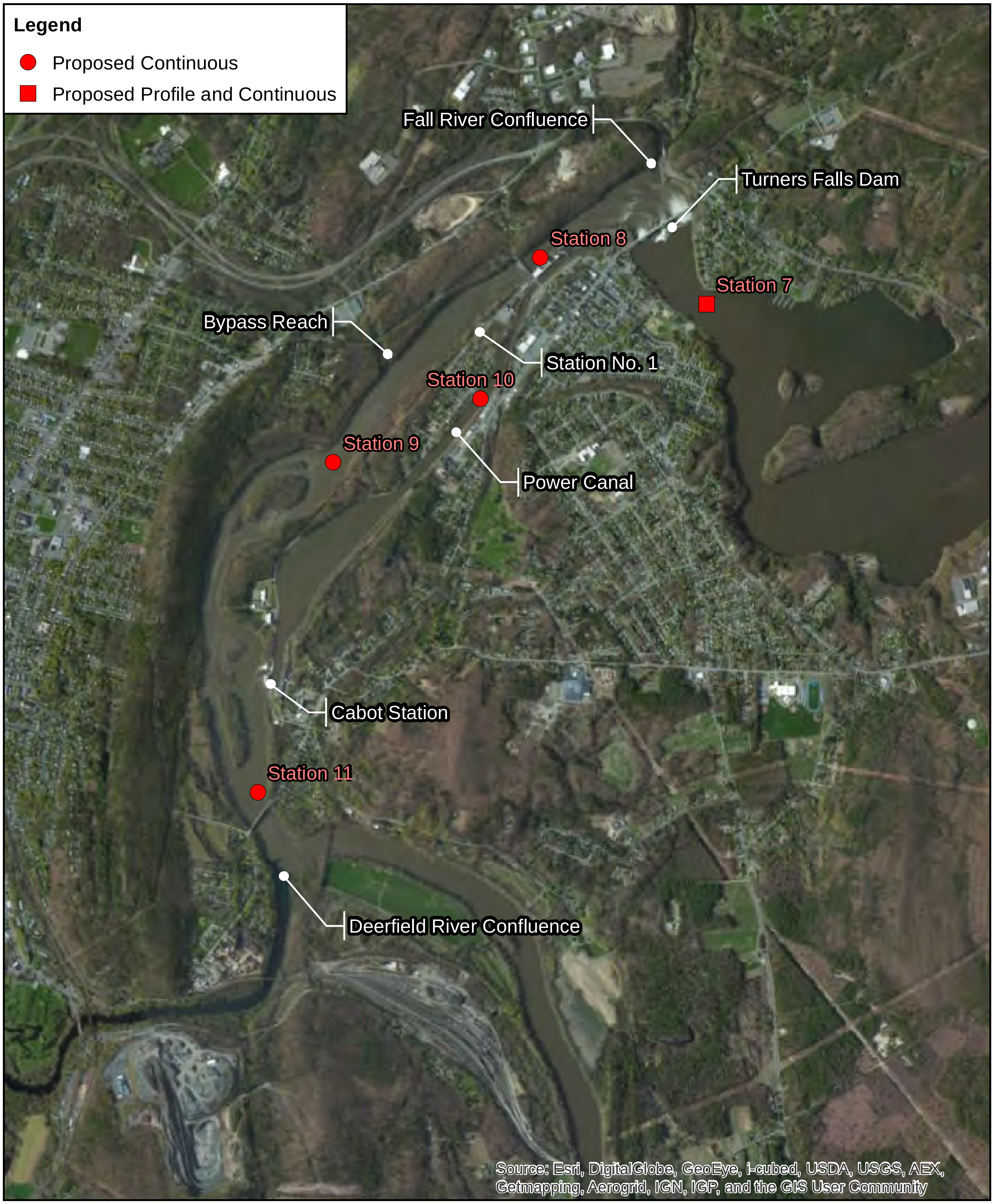

FirstLight Power Resources
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

0 0.25 0.5 1 Miles

Figure 3.2.1-2
Proposed Water Quality Sampling Locations Near Turners Falls Dam

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FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

Figure 3.2.1-3
Proposed Water Quality Sampling Locations Near the Northfield Mountain Tailrace

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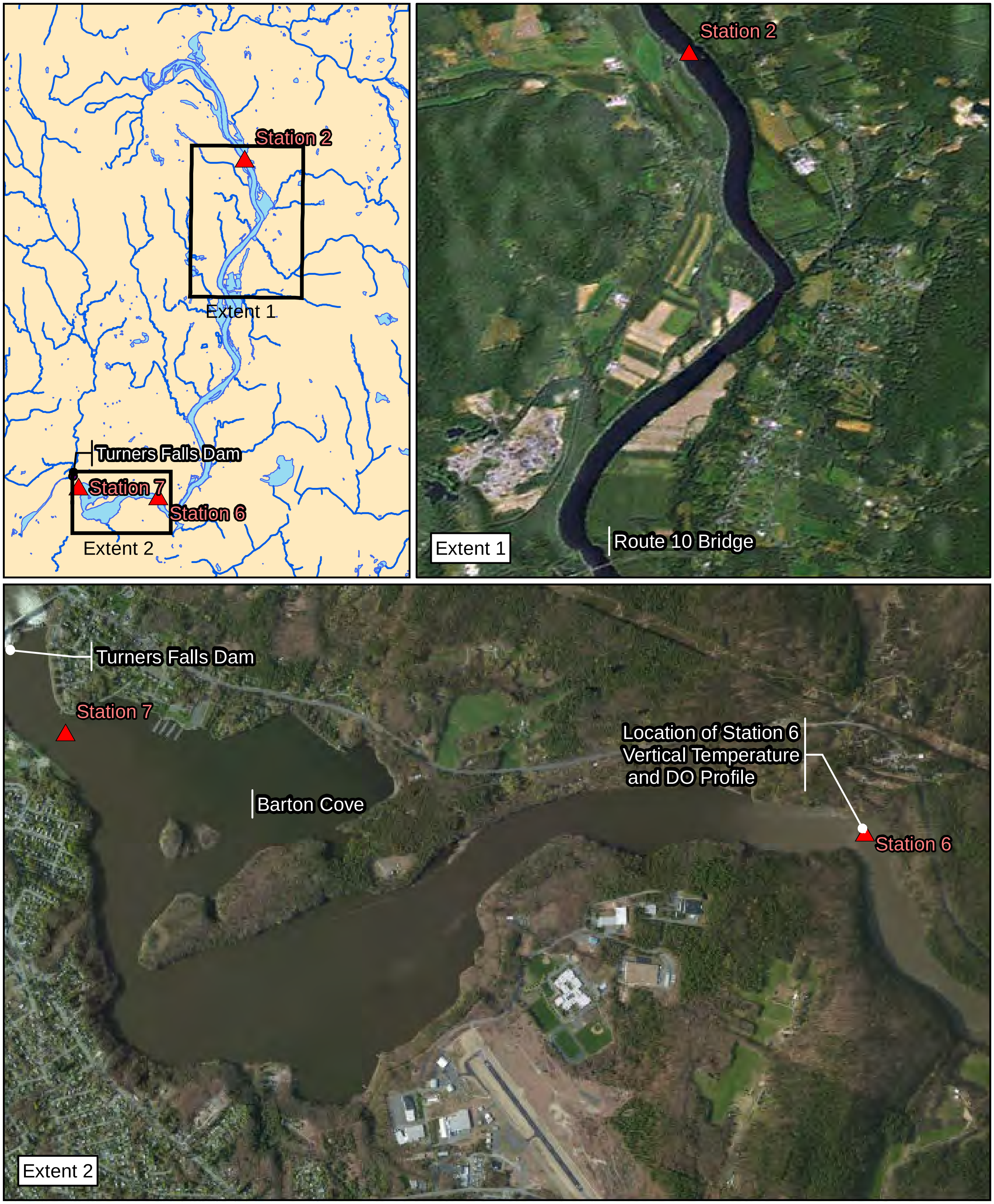

FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

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Figure 3.2.1-4
Turners Falls Impoundment Vertical Profile Locations

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3.2.2 Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot Station

General Description of Proposed Study

Background

Numerous stakeholders requested studies to evaluate how water level fluctuations associated with the Turners Falls Project and Northfield Mountain Project impact various environmental, geologic and recreational resources. Those studies include:

- Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*.

- Study No. 3.3.6 *Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the area of the Northfield Mountain and Turners Falls Projects*.

- Study No. 3.3.10 *Assess Operational Impacts on Emergence of State Listed Odonates in the Connecticut River*.

- Study No. 3.3.13 *Impacts of the Turners Falls Project and Northfield Mountain Project Operations on Littoral Zone Fish Habitat and Spawning*.

- Study No. 3.3.17 *Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitats*.

- Study No. 3.5.1 *Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species* (includes rare plants and tiger beetles).

- Study No. 3.6.6 *Assessment of Effects of Project Operation on Recreation and Land Use*.

Water level fluctuations in the Turners Falls Impoundment can be a function of:

- Hydropower operations including peaking releases from the Vernon Hydroelectric Project, Northfield Mountain Project Pumping and Generating Cycles, and peaking operations at the Turners Falls Project.
- Boat wakes.
- Natural flow variability. More specifically, water levels in the Turners Falls Impoundment will naturally rise and fall when flows exceed the hydraulic capacity of the hydropower facilities.

Water level fluctuations below Cabot Station can be a function of:

- Peaking operations at the Turners Falls Project when flow is within the hydraulic capacity of the facility.
- Peaking operations of several hydroelectric facilities on the Deerfield River.
- Boat wakes.
- Natural flow variability, when the hydraulic capacity of the Turners Falls Project is exceeded.

Study Description

FirstLight proposes to develop a hydraulic model of the Turners Falls Impoundment[20] and of the Connecticut River from Turners Falls Dam to Holyoke Dam. The proposed hydraulic model is the US Army Corps of Engineers' one-dimensional HEC-RAS. The purpose of the hydraulic model is to determine, for a given flow, the corresponding water surface elevation (WSEL) at a given location within the river- typically at a transect in the hydraulic model. In addition to predicting the WSEL for a given flow, the model also yields information on the river's depth and mean velocity at a given location (transect).

The HEC-RAS model can be run in both a steady state mode (flow is constant) and unsteady state mode (flow varies over time such as a hydrograph). FERC has requested that FirstLight develop an unsteady state HEC-RAS model in the Turners Falls Impoundment, bypass reach, power canal, and below Cabot Station to the upper limit of the Holyoke Impoundment. FirstLight proposes to develop two hydraulic models covering the a) Connecticut River from Turners Falls Dam upstream to Vernon Dam and b) Connecticut River from Holyoke Dam upstream to Turners Falls Dam. FirstLight maintains a nearly constant elevation in the power canal, except for periods of dewatering (refer to pages 4-93 through 4-97 showing power canal elevation duration curves). As the PAD elevation duration cures show there is very little WSEL fluctuations in power canal (duration analysis of 10 years of hourly elevations). Given the power canal's limited WSEL fluctuations, FirstLight does not believe a hydraulic model of the power canal is warranted.

<u>Study Goals and Objectives (18 CFR § 5.11(d)(1))</u>

The objectives of the hydraulic modeling study include:

- Provide WSEL (depth) and velocity information to help inform other environmental, geologic and recreation studies as listed above. For example, a study will be conducted to locate spawning habitat in the Turners Falls Impoundment. As part of that study, data will be collected on the depth of the spawning habitat. The hydraulic model results will be used by that study to assess whether Turners Falls Impoundment fluctuations could impact spawning habitat.

- An existing hydraulic model of the Turners Falls Impoundment will be used to determine the affect of a) the Vernon Hydroelectric Project, b) the Northfield Mountain Project, c) the Turners Falls Project d) naturally occurring high flows, and e) all three projects operating collectively on water level fluctuations in the Turners Falls Impoundment.

- An additional hydraulic model will be developed from the Turners Falls Dam downstream to Holyoke Dam to determine the effect of a) the Turners Falls Project, b) the Deerfield River Project, c) naturally occurring high flows and d) operations at Holyoke Dam on water level fluctuations. The rationale for extending the model to the Holyoke Dam is twofold. First the model requires a "downstream boundary condition". In this case the downstream boundary condition could be set at the FERC-licensed range of allowable fluctuation at Holyoke Dam of 1.4 feet (99.2 to 100.6 ft NGVD). The other reason for extending the model to Holyoke Dam is that operation (1.4 foot fluctuation) and hydraulic controls between Holyoke Dam and Rainbow Beach may influence water levels where the Puritan Tiger beetle is known to occur.

[20] As noted later, FirstLight has already developed a hydraulic model of the Turners Falls Impoundment and filed on February 22, 2013 a report. Based on the model findings, FirstLight will propose to reduce the current Project Boundary.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

FERC and many resource agencies requested studies to evaluate the impact of project operations – specifically water elevation fluctuations -- on environmental, geologic and recreational resources. This hydraulic modeling study will provide information on the relationship between water level fluctuations and project operations.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information- Turners Falls Impoundment Hydraulic Model

FirstLight has conducted numerous studies in the Turners Falls Impoundment related to erosion. One such study was conducted by Field Geology Services for use in studying fluvial processes/shoreline erosion in the Turners Falls Impoundment. To support the Field study, in 2006, a bathymetric map and two hydraulic models of the Turners Falls Impoundment were developed by Woodlot Alternatives Inc. (Woodlot) as summarized in the report entitled: *Connecticut River Hydraulic Analysis, Vernon Dam to Turners Falls Dam* (Woodlot, July 2007). The two hydraulic models include the one-dimensional HEC-RAS model, and the two-dimensional RIVER2D model.

As explained in FirstLight's report entitled: *Hydraulic Modeling Assessment of the Turners Falls Impoundment (*FirstLight, January 2013*)*[21], FirstLight updated the existing HEC-RAS model for use in evaluating the upstream influence of the Turners Falls and Northfield Mountain Projects. As noted in the report, the influence ends approximately 9,000 feet below Vernon Dam and thus FirstLight is proposing to modify its Project boundary. No new additional information is needed to develop a hydraulic model of the Turners Falls Impoundment.

At the May 14 study plan meeting, FERC requested further verification of the existing hydraulic model. FERC specifically requested that additional water level recorders be placed in the Turners Falls Impoundment at locations where the hydraulic grade line changes considerably, such as the area near Stebbins Island. The intent is to validate the existing HEC-RAS model with additional water level recorders at key locations.

Existing Information- FirstLight's Water Level Recorders (River Stage)

River stage and flow data at various locations are available to help calibrate hydraulic models. The following sections summarize the data available to assist in hydraulic model calibration.

As noted in the PAD, FirstLight maintains WSEL monitors[22] that record hourly at the following locations in the Turners Falls Impoundment:

- Immediately below Vernon Dam in the tailrace;
- In the Northfield Mountain tailrace;
- At the boat barrier located approximately 1,500 feet upstream of the Turners Falls Dam, and;
- At the Turners Falls Dam.

[21] This report was filed with FERC on February 22, 2013.
[22] All of the FirstLight WSEL monitors are on the same vertical datum.

In addition to the long-term WSEL monitors noted above, FirstLight maintained additional WSEL monitors for a portion of 2012 as described in the PAD (Section 4.3.2.6 2012 Water Level Monitoring Baseline Study) at the following locations:

- In the Turners Falls Impoundment at the Route 10 Bridge and West Northfield Road;
- In the bypass channel above and below Station No. 1 (although the period of available data is limited due to vandalism);
- In the Connecticut River below Cabot Station at the Route 116 Bridge and across from Rainbow Beach.

Existing Information- Additional Flow and Water Elevation Data

There are four USGS gages in the Project area as listed in Table 3.2.2-1.

Table 3.2.2-1: USGS Gages in Proximity to the Project Area

Gage No.	Gage Name	Drainage Area	Notes
01161000	Ashuelot River at Hinsdale, NH	420 mi^2	Drains into the Turners Falls Impoundment approximately 2.1 miles below Vernon Dam. A US Army Corps of Engineers Flood control facility is located above the gage (Surry Mountain Dam).
01166500	Millers River at Erving, MA	372 mi^2	Drains into the Turners Falls Impoundment immediately below the French King Bridge or approximately 3.9 miles upstream of Turners Falls Dam. A US Army Corps of Engineers Flood control facility is located above the gage (Birch Hill Dam).
01170000	Deerfield River near West Deerfield, MA	557 mi^2	Upstream of the gage are two seasonally operated reservoirs (Somerset and Harriman Reservoirs) and several peaking hydroelectric projects.
01170500	Connecticut River at Montague City, MA	7,860 mi^2	Located approximately 1,000 feet downstream from the Deerfield River confluence and approximately 0.74 miles below Cabot tailrace.

In addition to the USGS gages, FirstLight estimates flow at the following locations:

- Turners Falls "Naturally Routed Flow", which is a sum of the Vernon discharge, and flow contributions from the Ashuelot and Millers Rivers (pending the magnitude, the computation of "Naturally Route Flow" can be lagged).
- Flow through the gatehouse is estimated based on the gate rating curves and head differential between the WSEL monitored at the Turners Falls Dam Impoundment elevation and Keith's Bridge located in the power canal.
- Flow passed by the Turners Falls Dam is estimated based on the Turners Falls Dam Impoundment elevation and the rating curves of the bascule and tainter gates.

Existing Hydraulic Model- Flood Insurance Studies

Flood Insurance Studies (FIS) of the Connecticut River are available through the Federal Emergency Management Agency (FEMA). The FIS is used to show the area of inundation under various flood flows such as the 100-year flood. FEMA developed hydraulic models of the Connecticut River, including the reach between Turners Falls Dam and Holyoke Dam. The most recent hydraulic modeling was conducted in the early 1980s and most likely used the USACE's HEC-2 model, the predecessor to HEC-RAS. FirstLight will secure the original HEC-2 input files, and convert them over to the HEC-RAS model to develop a hydraulic model of the reach between Turners Falls Dam and Holyoke Dam. As described below, FirstLight is proposing to reconstruct the hydraulic model developed by FEMA for use in this relicensing effort.

Existing Hydraulic Model of the Connecticut River in the Northampton Area- Corps of Engineer Model

At the May 14 study plan meeting, The Nature Conservancy indicated that a HEC-RAS model had been originally developed by the US Army Corps of Engineers, which was subsequently updated (transects further widened) by The Nature Conservancy, in the Northampton area of the Connecticut River. The geographic extent of the model is shown in Figure 3.2.2-1. The model covers approximately 7 miles (60+ transects) of the reach below Cabot and will be incorporated into the proposed HEC-RAS model. Transects for the model were collected by the Corps in the fall 2011. Note that this area covers Rainbow Beach, an area of concern for tiger beetles.

Instream Flow Study Transects

FirstLight is proposing to accelerate Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass and below Cabot Station* such that field data is collected in 2013. As part of that study, FirstLight is collecting depth, velocity and WSEL data at transect locations to be determined. The field work will also include measuring the total flow at these transects. The information collected for this study could be used to supplement the hydraulic model proposed below for the reach below Turners Falls Dam. Note that the instream flow study work in 2013 will be limited to the reach from Turners Falls Dam to approximately the Deerfield River confluence. Instream flow study work in the reach below the Deerfield River confluence will occur in 2014 after a mussel survey of this same reach is completed in 2013. The mussel survey study will inform potential locations for transect placement.

Upland Topography

To develop a hydraulic model, the topography of upland areas (river banks and floodplain) is needed, particularly when simulating flood flows. If upland information is needed, FirstLight will rely on the existing upland mapping obtained from USGS National Map Viewer- more specifically, the USGS 10 meter digital elevation model (DEM).

Need for Additional Information

As noted above, FirstLight needs to obtain the FIS hydraulic models developed for the reach between Turners Falls Dam and Holyoke Dam. The hydraulic models are likely in paper format and will require re-entering the data in HEC-RAS. FirstLight is proposing to re-develop the FIS hydraulic models in lieu of developing an original model for the following reasons: a) the cost associated with conducting bathymetric mapping in the approximate 35-mile reach between Turners Falls Dam and Holyoke Dam is very expensive; and b) re-developing the FIS hydraulic model will provide sufficient information on the relationship between river stage and flow; and c) FirstLight installed water level monitors at two locations (Route 116 Bridge and at Rainbow Beach) in this reach during a portion of 2012 and there is also a long term water level monitor at the USGS gage at Montague. Thus, information is already available on the relationship between Turners Falls and Deerfield River Project operations and river stage.

As noted above, FERC has requested that water level recorders be placed in the Turners Falls Impoundment at key locations to verify the HEC-RAS hydraulic modeling results.

Project Nexus (18 CFR § 5.11(d)(4))

Project operations result in water level fluctuations in the Turners Falls Impoundment and below Cabot Station. These fluctuations may have an impact on various environmental, geologic and recreational resources.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Connecticut River Hydraulic Model from Vernon Dam to Turners Falls Dam

Task 1: Update Turners Falls Impoundment HEC-RAS model

The existing Turners Falls Impoundment HEC-RAS model does not include major tributary inflows, namely the Ashuelot and Millers Rivers. To date, the HEC-RAS model has been used to predict the WSEL under a constant (steady) flow throughout the length of the impoundment- meaning the flow at the Vernon tailrace is the same as the flow at Turners Falls Dam. FERC has requested that the HEC-RAS hydraulic model be operated in an unsteady mode allowing for time varying flow. To simulate time varying flow, the model would require updates including the Vernon Hydroelectric Project discharge hydrograph and flows recorded at the Ashuelot and Millers Rivers USGS gages. In addition, the model will require updates to reflect when water is leaving the impoundment (Northfield pumping) and when water is added to the impoundment (Northfield generating).

FirstLight records on its log sheets hourly Vernon discharges, and Ashuelot and Millers River flows based on the USGS gages to estimate the “Naturally-Routed Flow” through the impoundment. In addition, the log sheets include the hourly magnitude (MW) of pumping and generating, which can be converted to flow using a ratio of design flow (cfs) to capacity (kW) for both pumping and generating (see page 4-33 of PAD).

Task 2: Installation of Water Level Recorders in Turners Falls Impoundment for Model Verification

As noted above, FERC requested at the May 14 study plan meeting that water level recorders be placed in the Turners Falls Impoundment to further validate the hydraulic model. Figure 3.2.2-2 shows the channel bed and water surface profile (WSP) from the existing HEC-RAS model for flows of 15,938 (Turners Falls Hydraulic Capacity), 30,000 cfs 60,000 cfs and 100,000 cfs (this same figure was filed with FERC on February 22, 2013). More noticeable changes in the WSP were located to determine where water level recorders would be placed. Figure 3.2.2-3 (4 maps) shows the transect locations from the HEC-RAS model along with proposed[23] water level recorder locations (see Table 3.2.2-2 below). Note that each transect shown on Figure 3.2.2-3 is numbered- those numbers match the WSP (x-axis) in Figure 3.2.2-2.

Table 3.2.2-2: Proposed and Existing Water Level Monitors in Turners Falls Impoundment

Proposed Location of Water Level Recorder- (see HEC-RAS Transect No.)	Description	Rationale
Turners Falls Dam	Existing Gage: Located at Turners Falls Dam	
Transect No. 486.259: Turners Falls Boat Barrier Line	Existing Gage: Located just upstream of Turners Falls	Located below the French King Gorge

[23] FirstLight will seek to install the water level monitors as outlined in the table; however, if access is not granted to land, some re-location of recorders may be required.

Proposed Location of Water Level Recorder- (see HEC-RAS Transect No.)	Description	Rationale
	Dam	
Transect No. 26986.3: Northfield Tailrace	Existing Gage: Located in Northfield tailrace	Located above French King Gorge
Transect No. 30486.3: Located upstream of Northfield Tailrace	Proposed Gage: Located approximately 3,500 feet upstream of the Northfield Tailrace	At the May 14 meeting a question was raised that when Northfield is generating does it create a backwater upstream of the tailrace. This gage is positioned to record changes in the WSEL potentially due to Northfield operation. This gage may provide assistance in Study No. 3.1.2 to evaluate the rate of change in water level fluctuations.
Transect No. 71986.3: Located upstream of a Bridge	Proposed Gage: Located approximately 8.5 miles upstream of Northfield Tailrace	This location was selected because the river width narrows and could act as a hydraulic control – water levels start to rise at this approximate location based on Figure 3.2.2-2.
Transect No. 92986.3: Located below Stebbins Island	Proposed Gage: Located approximately 5,500 feet below lower most section of Stebbins Island	This gage would pick up the WSEL just below Stebbins Island.
Transect No. 102986: Located above Stebbins Island	Proposed Gage: Located approximately 2,500 feet above upper most section of Stebbins Island	This gage would pick up the WSEL just above Stebbins Island
Vernon Tailrace: Located immediately below Powerhouse	Existing Gage	

The proposed and existing water level monitors will be set to record the WSEL every 15 minutes. FirstLight will install these water level recorders from approximately August 2013 until approximately November 2013 to capture a range of low and high flows and to capture a range of operating conditions at the Vernon, Northfield and Turners Falls hydropower facilities. The water level monitors will be surveyed to the same datum as the existing water level recorders.

FirstLight will install these water level monitors from approximately August 2013 until approximately November 2013 to capture a range of low and high flows and to capture a range of operating conditions at the Vernon, Northfield and Turners Falls hydropower facilities.

In addition to the water level monitors, FirstLight will maintain hourly log sheets that will record the following data during the same period the water level monitors operate:

- Vernon Discharge (cfs)
- Northfield Pump and Generation (kW) - this will be converted to flow through a ratio of design flow (cfs) to design capacity (kW)
- Station No. 1 Generation (kW) – again this will be converted to flow
- Cabot Station Generation (kW)- again this will be converted to flow
- Flow recorded at USGS gages on the Ashuelot and Millers Rivers will be recorded

The log sheet information will be used along with the water level recorder data to help validate the model-see the following task.

Task 3: Model Verification and Calibration

Using the WSEL data obtained in Task 2, FirstLight will validate the hydraulic model to measured WSELs. The hydraulic model will be calibrated to measured WSELs in the Turners Falls Impoundment for select flows. The HEC-RAS model will be operated as steady state with no pumping or generating occurring at Northfield such that flow conditions through the length of the impoundment are relatively steady for several hours. FirstLight has developed a relationship between flow and travel time (in hours) through the Turners Falls Impoundment. As a guide, at flows less than 20,000 cfs, the travel time is approximately 10 hours, and at flows near 80,000 cfs, the travel time is approximately 4 hours. Ideal conditions would be if discharges from Vernon are relatively constant for 12+ hours and Northfield is idle. The HEC-RAS model will be operated for a given flow and the WSELs measured at FirstLight monitoring locations will be compared to the model results. If needed, calibration will consist of adjusting Manning n values (roughness) or adjusting contraction/expansion coefficients within reasonable measures such that the measured and modeled WSELs are reasonably close.

Task 4: Unsteady Flow Model

Once the model is calibrated, it will be updated to simulate unsteady flow conditions. In this case, time varying flows will be simulated to determine changes in the WSEL at select locations in the Turners Falls Impoundment. Several production runs/sensitivity analyses will be conducted to evaluate various sources relative water level influences. For example, a time varying discharge hydrograph from Vernon Station will be simulated while the Northfield Mountain Project remains idle to determine the contribution of water level fluctuations caused by Vernon Station. Similarly, a constant discharge hydrograph from Vernon Station will be simulated while the Northfield Mountain Project is operated as a pump or generator. Finally, other combinations of flows and operating conditions at the facilities will be evaluated. A matrix of proposed model runs is included in Table 3.2.2-3. Output from the model will include WSEL and average channel velocities[24] for the flows simulated.

Connecticut River Hydraulic Model from Turners Falls Dam to Holyoke Dam

Task 5: Contact FEMA and Obtain FIS Hydraulic Model

FirstLight will contact FEMA to obtain the FIS studies in those communities located between Turners Falls Dam and Holyoke Dam. Experience indicates that FIS studies conducted in the early 1980s were conducted using HEC-2, the predecessor to HEC-RAS. Note that the energy equations and computations between both models are the same, although HEC-RAS has more features and graphical displays. It is likely that the original HEC-2 input files are retained on microfiche. FirstLight will obtain the microfiche, and print out the input files. The input files contain the following information which will entered into the HEC-RAS model:

- Channel transect coordinates.
- Mannings “n” values.
- Distance between transects.

[24] Note that HEC-RAS model can calculate velocities laterally across the transect based on conveyance. These velocities will reflect average velocities for the transect.

- Bridge geometry[25].
- Expansion and contraction coefficients.
- Flood flows.

Task 6: Development of HEC-RAS model and Model Calibration

The data on the printed input files will be entered into the HEC-RAS model. The FIS will be re-constructed and validated by simulating the 100-year flood flow to ensure that the HEC-RAS model output—specifically, the water surface profile—reasonably matches that shown in the FIS. Once the model reasonably matches the 100-year water surface profile, it will used to simulate various steady state flows similar to the methodology described above. For example, one of the flows simulated will be a relatively constant flow throughout the 35-mile long reach experienced during the period for which FirstLight has WSEL data at the Route 116 Bridge and Rainbow Beach. The measured WSEL at these two locations and at the Montague USGS gage will be compared to that predicted by the model. Similar to above, the model will be calibrated by adjusting Manning n values or expansion/contraction coefficients within reasonable measures.

Once the FIS is recreated and calibrated, it will be updated to include the HEC-RAS transects included in the Corps/TNC hydraulic model as described above. Any FIS transects in this reach (see Figure 3.2.2-1) will be replaced with the more up-to-date transects from the Corps/TNC model. The hydraulic model will be re-run again to determine if measured WSELs reasonably match model WSELs.

As part of Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station*, FirstLight will be obtaining additional transect and geomorphic data to support this study. For those locations where transects are obtained, they too will be added into the HEC-RAS model. Also, Study No. 3.3.1 requires collecting stage discharge relationships at transects (final locations to be determined) that will be added into the model. These data, along with the WSEL monitoring data obtained in 2012 will be used to calibrate the model to observed WSELs.

Task 7. Unsteady Flow Model

After calibration, the model will be updated to simulate unsteady flow conditions. Time varying flows will be simulated to determine WSEL changes at select locations in the 35-mile long reach. Sensitivity analyses will be conducted to evaluate the effect of various sources on water level fluctuations. In this case, water level fluctuations could be a function of, or influenced by, the Turners Falls Project, the Deerfield River Project, and the WSEL maintained at Holyoke Dam (1.4 foot fluctuation permitted). For example, a time varying discharge hydrograph from the Turners Falls Project will be simulated while flows from the Deerfield River remain stable to determine the effect of the Turners Falls Project operations on water level fluctuations. Similarly, a constant discharge hydrograph from the Turners Falls Project will be simulated while the Deerfield River Project discharges vary. Finally, other combinations of flows, operating conditions at the Turners Falls and Deerfield River Project, and starting downstream boundary conditions (Holyoke Dam elevation) will be evaluated. A matrix of proposed model runs is included in Table 3.2.2-4. Output from the model will include WSEL and average channel velocities for various flows.

[25] FirstLight will contact MassDOT to obtain any bridge information (pier shape, low chord, etc.) to determine if the bridge data contained in the HEC-2 model reflects today's bridge geometry.

Task 8: Report

A comprehensive report will be developed to include the following:

- Introduction
- Project Layout
- Summary of Existing Data
    - Existing USGS Gage Flow
    - Flow in Power Canal and Passed at Turners Falls Dam
    - Water Level Recorders
- Hydraulic Modeling
    - Connecticut River between Vernon and Turners Falls Dams
    - Connecticut River between Turners Falls and Holyoke Dams
    - Steady State Modeling
    - Calibration
    - Unsteady State Modeling
- Findings
- References

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Projects on water level fluctuations. The HEC-RAS model of the Connecticut River between the Vernon and Turners Falls Dams is essentially complete with the exception of calibrating to observed WSELs and simulating unsteady flow conditions. More time will be spent developing the HEC-RAS model of the Connecticut River between Turners Falls and Holyoke Dams. The estimated cost of this study is between $100,000 and $120,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013; this particular study was discussed in much greater detail on May 14th in the afternoon.

As noted above, FirstLight will install water level recorders in 2013 (August-November) at the locations shown in Figure 3.2.2-3 in the Turners Falls Impoundment for use in validating and calibrating the hydraulic model. Model verification and validation would be conducted in 2014.

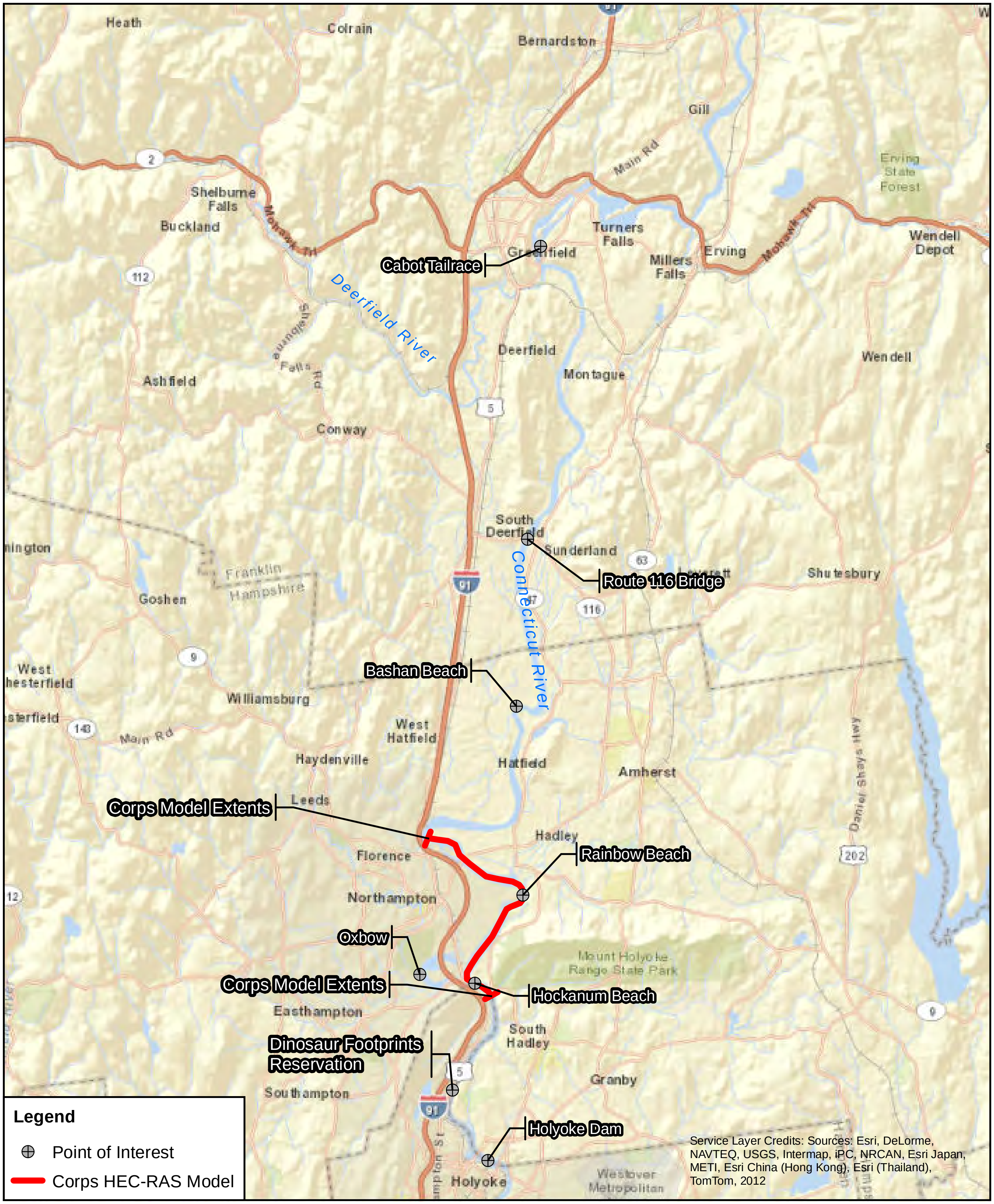
Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Table 3.2.2-3: Turners Falls Impoundment Hydraulic Model- Proposed Model Production Run Matrix

	Vernon		Northfield			Power Canal		Turners Pond Level	
Scenario No.	Max Gen	Min Gen	Max Gen	Max Pump	Off	Max Gen	Min Gen	Max Pond	Min Pond
1	X		X			X		X	
2	X		X			X			X
3	X		X				X	X	
4	X		X				X		X
5	X			X		X		X	
6	X			X		X			X
7	X			X			X	X	
8	X			X			X		X
9	X				X	X		X	
10	X				X	X			X
11	X				X		X	X	
12	X				X		X		X
13		X	X			X		X	
14		X	X			X			X
15		X	X				X	X	
16		X	X				X		X
17		X		X		X		X	
18		X		X		X			X
19		X		X			X	X	
20		X		X			X		X
21		X			X	X		X	
22		X			X	X			X
23		X			X		X	X	
24		X			X		X		X

Table 3.2.2-4: Connecticut River below Cabot Station Hydraulic Model- Proposed Model Production Run Matrix

	Turners Falls		Deerfield		Holyoke		Holyoke Pond Level	
Scenario No.	Max Gen	Min Gen	Max Gen	Min Gen	Max Gen	Min Gen	Max Pond	Min Pond
1	X		X		X		X	
2	X		X		X			X
3	X		X			X	X	
4	X		X			X		X
5	X			X	X		X	
6	X			X	X			X
7	X			X		X	X	
8	X			X		X		X
9		X	X		X		X	
10		X	X		X			X
11		X	X			X	X	
12		X	X			X		X
13		X		X	X		X	
14		X		X	X			X
15		X		X		X	X	
16		X		X		X		X



FirstLight Power Resources
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FIRSTLIGHT POWER RESOURCES

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0 2 4 8 Miles

Figure 3.2.2-1: Geographic Limits of Corps HEC-RAS Model

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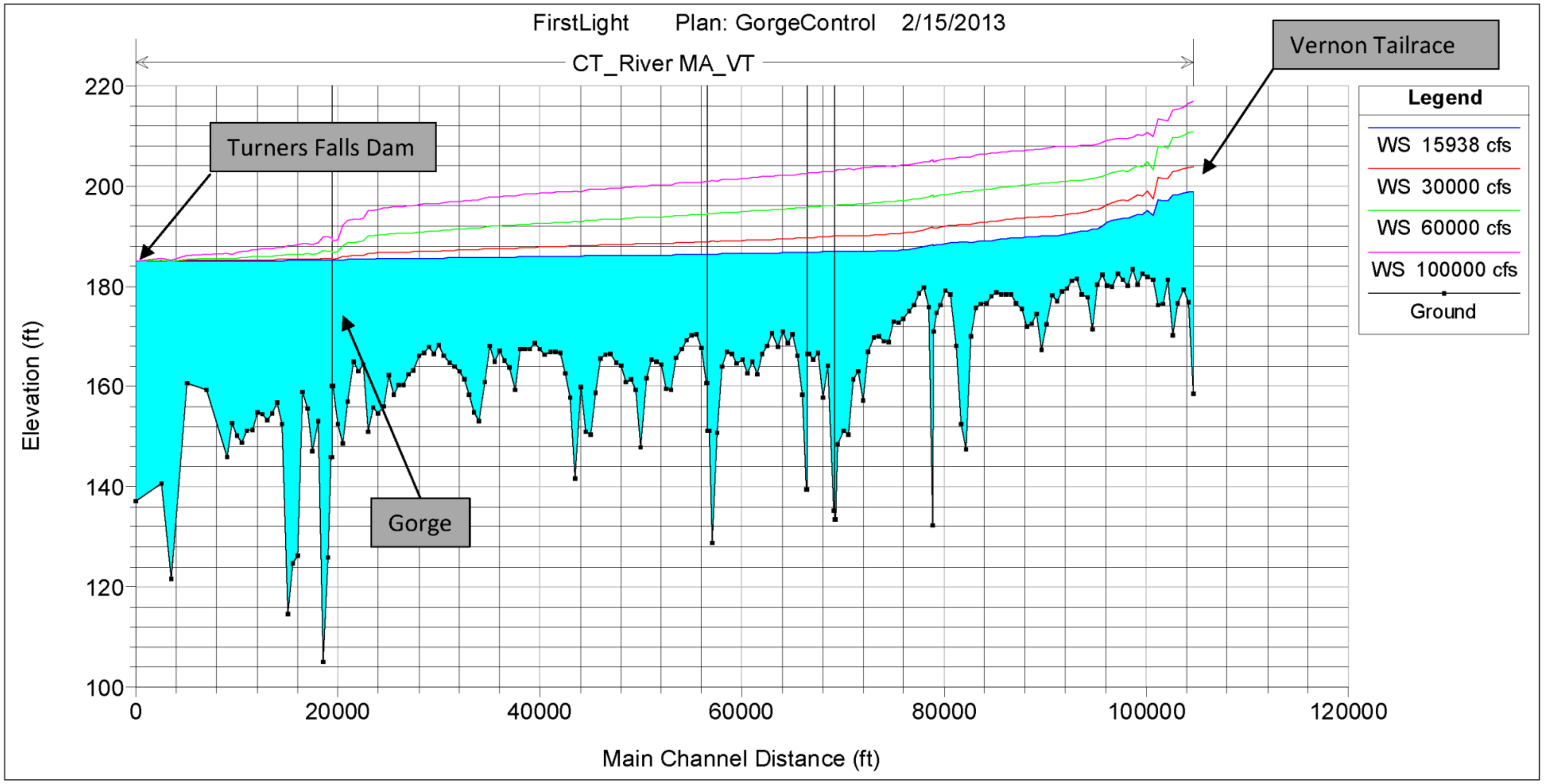
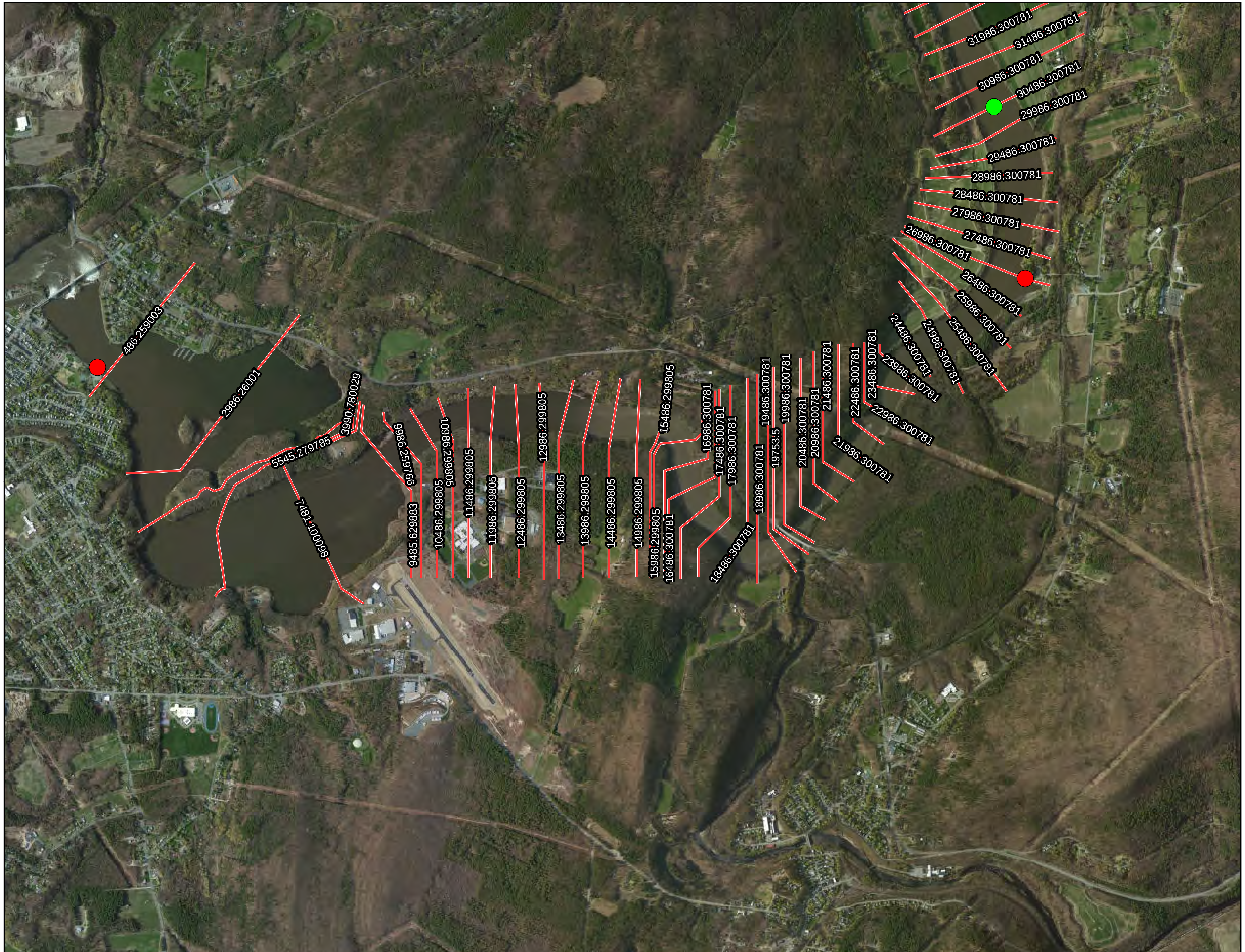
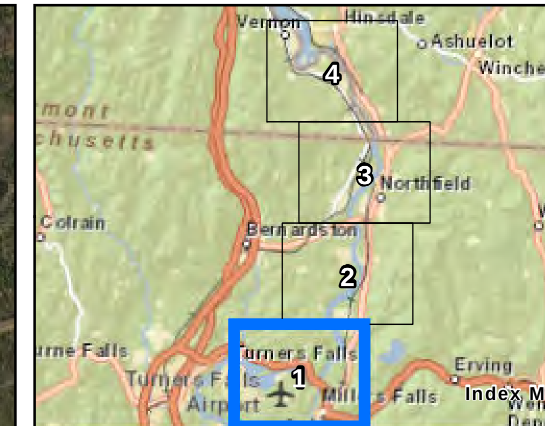


Figure 3.2.2-2: Turners Falls Impoundment from Turners Falls Dam to Vernon Tailrace- Water Surface Profile for Various Flows





FIRSTLIGHT POWER RESOURCES
HYDRAULIC STUDY OF
TURNERS FALLS IMPOUNDMENT

Figure 3.2.2-3
Plan Map of Turners Falls Impoundment
HEC-RAS Transect Numbers
Page 1 of 4

Legend

- Cross Section
- Existing Water Level Recorder
- Proposed Water Level Recorder

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

0 1,000 2,000 4,000 Feet

1 inch = 2,000 feet

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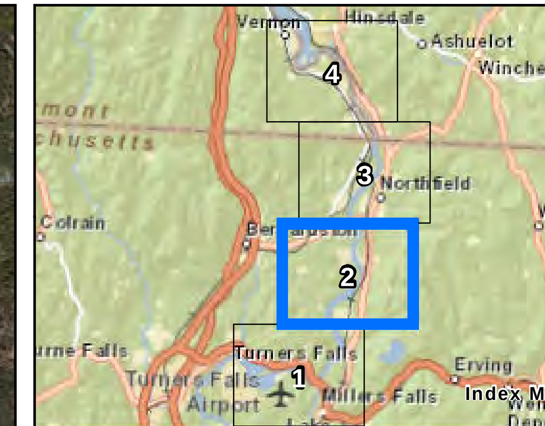

FIRSTLIGHT POWER RESOURCES
HYDRAULIC STUDY OF
TURNERS FALLS IMPOUNDMENT

Figure 3.2.2-3
Plan Map of Turners Falls Impoundment
HEC-RAS Transect Numbers
Page 2 of 4

Legend

- Cross Section
- Existing Water Level Recorder
- Proposed Water Level Recorder

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

0 1,000 2,000 4,000 Feet

1 inch = 2,000 feet

FirstLight Power Resources
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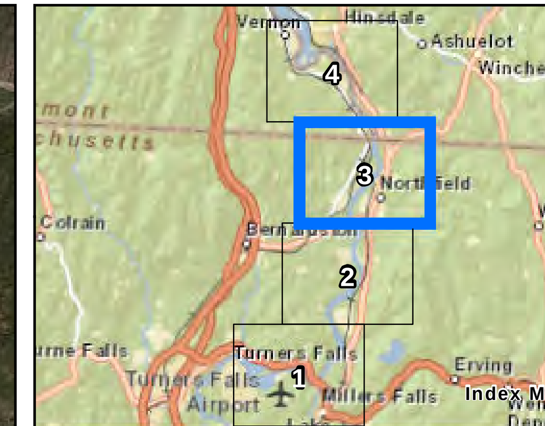

FIRSTLIGHT POWER RESOURCES
HYDRAULIC STUDY OF TURNERS FALLS IMPOUNDMENT

Figure 3.2.2-3
Plan Map of Turners Falls Impoundment HEC-RAS Transect Numbers
Page 3 of 4

Legend

- Cross Section
- Existing Water Level Recorder
- Proposed Water Level Recorder

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

FirstLight Power Resources
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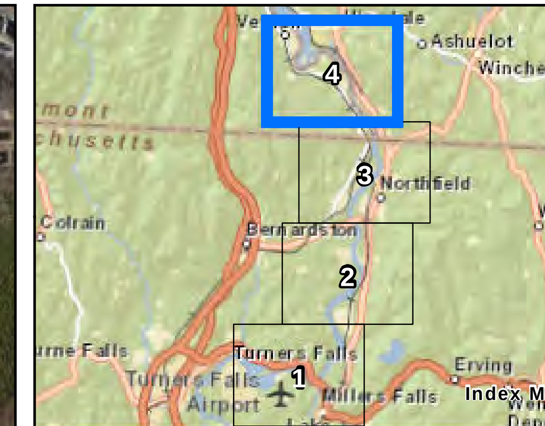

FIRSTLIGHT POWER RESOURCES
HYDRAULIC STUDY OF
TURNERS FALLS IMPOUNDMENT

Figure 3.2.2-3
Plan Map of Turners Falls Impoundment
HEC-RAS Transect Numbers
Page 4 of 4

Legend

- Cross Section
- Existing Water Level Recorder
- Proposed Water Level Recorder

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

0 1,000 2,000 4,000 Feet
1 inch = 2,000 feet

FirstLight Power Resources
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3.3 Fish and Aquatic Resources

3.3.1 Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station

General Description of Proposed Study

USFWS, NOAA, MDFW, NHFG, CRWC, TNC and TU requested that a habitat-based field study, such as the Instream Flow Incremental Methodology (IFIM) be conducted in the Turners Falls bypass reach and in the Connecticut River downstream of Cabot Station. An IFIM study is proposed to quantify the relationship between station operation and aquatic habitat.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The purpose of the study is to assess the potential effects of the range of discharges from Turners Falls Dam, Station No. 1, and Cabot Station on wetted area and aquatic habitat suitability in the Connecticut River between Turners Falls Dam and Cabot Station (the bypass reach) and below Cabot Station downstream to the Route 116 Bridge in Sunderland, MA.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals identified are to:

- Determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge.
- Determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Route 116 Bridge in Sunderland, MA.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In 2012, aquatic habitat mapping and water level monitoring were conducted at the following locations:

Habitat Mapping

- In the Connecticut River bypass reach from Turners Fall Dam to Cabot Station, and;
- In the Connecticut River from Cabot Station approximately 30 miles downstream to a natural hydraulic control located in the vicinity of the Dinosaur Footprints Reservoir (see Figure 3.3.1-1).

Water Level Recorders

- From approximately late April 2012 through mid August 2012, FirstLight installed continuously recording water level loggers that measured the change in water elevations. Two loggers were placed in the bypass reach from Turners Falls Dam to below Cabot Station (although vandalism was an issue), and three loggers were placed below Cabot Station (at the existing Montague USGS gage, at the Route 116 Bridge in Sunderland, and at Rainbow Beach in Northampton). See Figure 3.3.1-2 for a map showing the logger locations. All loggers were surveyed to a common datum to allow for comparison. Appendix E of the PAD contains weekly plots of the data obtained from these water level loggers.

The 2012 aquatic habitat mapping report entitled "*Aquatic Mesohabitat Assessment and Mapping*" prepared by FirstLight (2012) was filed with FERC on January 8, 2013. It also can be found on FirstLight's relicensing website at http://www.northfieldrelicensing.com.

Freshwater Mussels

Freshwater mussel habitat is a stakeholder concern. Using existing data and data collected under this and another relicensing study (Study Plan 3.3.16 *Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station)* the potential effects of Project operations will be examined on mussel habitat downstream of the Turners Falls Dam. Existing information includes data collected in 2011, when a freshwater mussel survey was conducted in the Turners Falls Impoundment, bypass reach, and canal as a baseline study in anticipation of the FERC relicensing process. State-listed mussel species were not detected in any of these areas (Biodrawversity, 2012). As part of the requirements of the FERC license for the Holyoke Dam, freshwater mussel studies have been conducted at four-year intervals in that project area, which includes the area from Dry Brook (Sunderland) to the Holyoke Dam, plus the bypass reach and power canals (this survey is scheduled to occur again in 2013).

These studies, combined with a survey proposed by FirstLight in 2013 from Cabot Station downstream to Route 116 Bridge in Sunderland will provide information on the distribution and habitat of common and state-listed mussel species in the Connecticut River in the instream flow study area.

Project Nexus (18 CFR § 5.11(d)(4))

Per the FERC license, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow, whichever is less, below the Turners Falls Project year-round. FirstLight typically maintains the minimum flow requirement through discharges at Cabot Station and/or Station No. 1.

Per the FERC license, a continuous minimum flow of 200 cfs is maintained in the Connecticut River bypass reach starting on May 1, and increases to 400 cfs when fish passage starts by releasing flow through a bascule gate[26]. The 400 cfs continuous minimum flow is provided through July 15, unless the upstream fish passage season has concluded early in which case the 400 cfs flow is reduced to 120 cfs to protect shortnose sturgeon. A 120 cfs continuous minimum flow is maintained in the bypass reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15th. The 120 cfs flow release was determined in 1993 in consultation with MADFW, NMFS, and USFWS to ensure that an adequate zone of passage exists in the reach during the months when sturgeon may be present and require volitional movement.

Approximately 87% of the inflow to the Turners Falls Impoundment is controlled by discharges from the Vernon Hydroelectric Project. The majority of the remaining 13% percent of inflow to the Turners Falls Impoundment is from the Ashuelot and Millers Rivers. The Vernon Hydroelectric Project has a hydraulic capacity of 17,130 cfs, while the hydraulic capacity of the Turners Falls Project (Cabot and Station No. 1 combined) is approximately 15,938 cfs. When flows are within the hydraulic capacity of the Vernon Hydroelectric Project, inflows to the Turners Falls Impoundment reflect peaking discharges.

[26] The bascule gate used to pass the minimum flow is located at the Turners Falls Dam and is the one closest to the gatehouse.

FirstLight operates the Turners Falls Project as a peaking facility when flows are in the hydraulic range of the Turners Falls Project and as a run-of-river facility when flows exceed the hydraulic capacity of the Turners Falls Project (15,938 cfs). The Northfield Mountain Project operates as a peaking project.

Project operations have the potential to influence aquatic habitat in the bypass reach and below Cabot Station. Based on water level monitoring studies conducted in 2012, it appears that hydraulic effects of peaking operations may extend downstream to Rainbow Beach, approximately 25 miles below Cabot Station; however, significant habitat effects attenuate rapidly below Sunderland, MA.

The Connecticut River immediately below Cabot Station has been identified as a major spawning area and overwintering area for the Endangered Species Act (ESA)-listed shortnose sturgeon. Other diadromous species such as American shad adults and juveniles, blueback herring and sea lamprey seasonally utilize habitat in this vicinity for spawning and rearing. American eels also utilize the habitat in this reach.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Background

The scope of this study is to quantify the effects of Project flows on aquatic habitat suitability in the Connecticut River for the aquatic community and its managed fish resources, including diadromous and resident fish species, and aquatic invertebrates. These data will then be used in conjunction with hydrologic, operational and other models to evaluate the costs and benefits of potentially providing alternate habitat-based flows to the Connecticut River in the study area.

Task 1: Consult with Agencies and Interested Stakeholders to Determine Study Area, Study Reaches, and Habitat Suitability Index Curves

Study Area

The Connecticut River segment between the Turners Falls Dam and the Route 116 Sunderland Bridge (Figure 3.3.1-1) was identified by the applicable state and federal fishery agencies (agencies) as the study area for purposes of the habitat based study. Flow in this reach is cumulatively influenced by discharges from upstream tributaries, hydroelectric projects in the upper Connecticut River, Fall River (to the bypass reach), the Turners Falls Project and the Northfield Mountain Project. Additional discharges to the study area immediately below Cabot Station include the Deerfield River, which contributes approximately 665 square miles (mi^2) of additional drainage area. The Deerfield River includes several FERC-licensed hydroelectric projects operating as peaking facilities and two seasonal regulated storage reservoirs-Somerset and Harriman Reservoirs in Vermont. The river downstream of Route 116 Bridge is backwatered by the upstream end of the Holyoke Dam impoundment (Study Reach 5 – see detailed description of study reaches below). The specific modeling approach and level of effort related to this reach will be contingent on the outcome of the 2013 mussel survey (which will inform potential study sites), and will be determined with further stakeholder consultation following review of the mussel survey.

An IFIM study is proposed to develop an understanding of key habitat suitability-flow relationships in the study area. This will be quantified by using a Physical Habitat Simulation (PHABSIM) model or the equivalent. The model(s) will be used to simulate habitat suitability at various flow increments representing selected anadromous and resident fish species, and aquatic biota (i.e., macroinvertebrates). One-dimensional (transect-based) and/or two dimensional (finite elements-based) hydraulic models are required to simulate river channel hydraulics in various areas of interest.

Consistent with IFIM protocol, a study team comprised of licensee representatives and qualified technical experts will be formed for the purpose of making technical decisions regarding input parameters and review of study output. Specifically, that study team will collaboratively designate:

1. specific spatial and temporal habitat management goals,
2. boundaries of the study area and reaches,
3. locations of specific representative or critical study sites, and study site transects,
4. Habitat Suitability Index (HSI) criteria for applicable species and lifestages, and
5. calibration flows and range of flows to be assessed.

Study Reaches and Transect Selection (1-D and 2-D Modeling)

The proposed study methodology involves a phased approach beginning with review of recently-mapped mesohabitat distribution throughout the study area. The mapping and characterization of aquatic mesohabitat provides essential information regarding the extent, location, and composition of aquatic habitats that may be affected by Project operation, and provides a framework for selecting strategic study sites and transects.

Study reach boundaries are typically placed at significant breaks in geomorphic, hydrologic or habitat use in the study area (Bovee et al., 1998)[27]. The study team will consult to define study reaches and select applicable study sites within each reach, as well as cell boundaries and transects in areas of 1-dimensional (1-D) modeling within each study site. A site visit has been scheduled for July 2013 to select transect locations and review 2-D options in the study area from the Turners Falls Dam downstream to the Deerfield River confluence.

Study sites may represent typical and/or unique but critical habitats within each reach. For 1-D model applications, the study team will select upstream and downstream cell boundaries within each study site based on localized observed shifts in stream width, cover, substrate, and hydraulics. The area between a pair of cell boundaries is considered to be relatively homogenous and is described by a transect located within the cell. Study team participants will locate cell boundaries and have input to transect placement within cell boundary pairs. MDFW has requested that transects should be located in suitable mussel habitat. MDFW will have representation on the study team to select the transect locations in 1-D study areas.

Based on discussions with the study team, due to complex flow patterns near the islands above the Cabot Station tailrace, a 2-D model is proposed from the upstream end of the Rawson Island to just below the Deerfield River confluence (specifically at the USGS Gage at Montague). The study team with the input of a hydraulic modeler will also evaluate the need to develop a 2-D model in Reach 1 immediately below the Turners Falls Dam downstream to the sharp bend in the bypass reach, as well as the downstream-most segment of Reach 2 around the Rawson Island complex during the July 2013 site visit.

Project operations and configuration affect flow and habitat in distinct ways. For this reason, four study reaches are recommended for modeling purposes (see an overview of locations in Figure 3.3.1-1 and a close-up of the bypass reach area in Figure 3.3.1-3). The following study reaches are proposed:

- **Reach 1. Upper Bypass Reach**. This reach is approximately one mile long extending from the Turners Falls Dam downstream to the confluence with the Station No. 1 tailrace. Habitat and flow in this reach are influenced by discharges from the Turners Falls Dam, attraction and fishway

[27] Differences in slope, geomorphology, substrate, and flow influence, suggest that four reaches may be justifiable.

flows for the Spillway fish ladder and the Fall River (see Figure 3.3.1-3 for location). Stream channel structure and geomorphology are controlled primarily by bedrock. From the Turners Falls Dam to just below the Fall River confluence, the bypass channel is significantly wider than other reaches, dominated by scoured ledge substrate, and the thalweg poorly defined, before narrowing just upstream from the Station No.1 tailrace. Mesohabitat in this reach includes pool, run and riffle with bedrock overlaid with rubble and cobble substrates. The study team will conduct a site visit at a safe and low flow, to evaluate potential modeling needs in the pool and ledge complex below the dam, where a 2-D model may be required, depending on the outcome of the site visit.

- **Reach 2. Lower Bypass Reach**. This reach is approximately two miles long extending from the Station No. 1 tailrace downstream, terminating at an island complex and a geological feature including a natural ledge drop known as "Rock Dam". Flow is influenced by both the net discharge from Reach 1, as well as Station No. 1, when generating. Stream channel structure is controlled primarily by bedrock. Reach 2 channel morphology is relatively well defined, and includes pool, run and riffle mesohabitats with bedrock overlaid with rubble and cobble substrates. The need to employ a 2-D model in the lower portion of this reach (where flow bifurcates around Rawson Island) will be evaluated in the field.

- **Reach 3. Tailrace Reach**. The tailrace reach extends from below the Rock Dam/Rawson Island complex downstream to the USGS Gage No. 01170500 at Montague, which includes the confluence with the Deerfield River. Habitat in this reach is influenced by flows from Reaches 1 and 2 as well as generation at Cabot Station including backwatering around the island complex upstream to the toe of Rock Dam. Stream channel structure is comprised of alluvial deposits, including a series of island and split channel complexes both upstream, across, and downstream from the Cabot Station powerhouse. Hydraulic effects are complex, and include backwatering from Cabot Station upstream to Rock Dam as well as flow between islands. Habitat is primarily riffle and run; substrate is dominated by gravel bars and cobble, and includes ledge outcrops at the General Pierce Bridge area.

Two additional reaches have been identified for future modeling, but will not be initially modeled in 2013, pending investigations pertaining to freshwater mussel habitat. These reaches are:

- **Reach 4. Downstream Reach**. This reach extends from the Montague gage to the Sunderland Bridge (Route 116), which is where backwater influence of the Holyoke Project impoundment generally is detected. Flow is primarily influenced by outflow from Reaches 1-3 and the Deerfield River. This section of river is alluvial and low gradient, with well defined channel and embankments, and repeating patterns of pool and run habitat. Substrate varies but is dominated by cobble, gravel and fines. This reach will be modeled using a 1-D PHABSIM model.

- **Reach 5.** This section of the river extends from the Route 116 Bridge to a natural hydraulic control located in the vicinity of Dinosaur Footprints Reservation. It is a low gradient, alluvial reach with limited mesohabitat variability and in many cases very gradual or subtle transitions from one mesohabitat type to the next contiguous type. Over 75% of the mesohabitat in this reach is comprised of run and most or the remainder is pool. Hydraulics in this reach are influenced by backwatering effects from the downstream Holyoke Project. The modeling approach for this reach will be further evaluated in consultation with the study team and is presently proposed to involve collecting water surface elevation data and hydraulic modeling (See Study Plan 3.2.2) in areas with suitable habitat for target species such as freshwater mussels.

Transect selection and field work for Reaches 4 and 5 is proposed to occur in 2014 once the location and extent of freshwater mussel populations has been collected and evaluated.

Habitat Suitability Index Criteria

FirstLight anticipates the use of habitat suitability index curves (HSI) curves adopted primarily from those previously used in support of recent PHABSIM models conducted at study sites with similar geomorphic and ecoregion characteristics. FirstLight has begun agency consultation to select applicable HSI curves. Although most have been resolved, several categories are continuing to be researched and modified as necessary and approved by the study team at this time. Based on consultation with agencies, and stakeholders, FirstLight proposes to evaluate the following HSI criteria (Table 3.3.1-1).

Attachment A includes a set of proposed HSI curves and supporting references. The following guilds have been proposed for inclusion, to capture habitat requirements for species for which HSI curves are not otherwise available:

- Shallow-slow
- Shallow-fast
- Deep-slow
- Deep-fast

FirstLight will continue to consult with the study team to further classify applicable fish species into guilds and assign depth and velocity criteria to each guild, prior to developing the PHABSIM model.

The documented location of shad spawning in the Connecticut River between Holyoke Dam and Turners Falls Dam was identified in previous studies by Layzer (1974) and Kuzmeskus (1977). The documented spawning locations are shown in Figure 3.3.1-4.

Freshwater mussels

Freshwater mussel habitat suitability will be assessed in all study reaches. In the event satisfactory mussel Habitat Suitability Indices for freshwater mussels cannot be developed[28], the habitat suitability will be evaluated with host fish species criteria, using host species specific to each mussel species. Host fish habitat suitability will either use the criteria specific to a host species which is already a target species with established criteria or through the use of habitat guild criteria. Target mussel species' preferred habitat and their host species (Nedeau, 2008) are shown in Table 3.1.1-2. This approach has been employed in instream flow modeling recently completed in southern New Hampshire rivers.

Host fish species associated with eastern elliptio and eastern floater are habitat generalists which are poor indicators of fluvial habitat suitability. FirstLight therefore is not proposing to add these criteria to the analysis. For the alewife floater and the eastern pondmussel, FirstLight is proposing to utilize the host species American shad juvenile and adult criteria for analyzing habitat suitability. For the yellow lampmussel and the triangle floater, FirstLight proposes to utilize fluvial host fish criteria (white sucker),

[28] FirstLight proposes to adapt empirical data collected within Reach 4 during the mussel survey work described under Study No. 3.3.16 to develop HSI criteria specific to yellow lampmussel if this species is found there in sufficient abundance. These criteria can then be applied retroactively to transect data collected in the field in Reaches 1, 2 and 4.

for analyzing habitat suitability for these mussel species, in the event satisfactory mussel Habitat Suitability Indices for freshwater mussels cannot be developed.

Table 3.3.1-1: Target Species and Life Stages Proposed for the IFIM Study Reaches.

Study Reach	Species	Lifestage/criteria
Reach 1 and 2	American shad	zone of passage
	American shad	spawning and incubation
	blueback herring	zone of passage
	blueback herring	(use American shad HSI as a surrogate)
	white sucker	zone of passage
	white sucker	spawning, fry, juvenile, adult
	fallfish	spawning, fry, juvenile, adult
	walleye	spawning, fry, juvenile, adult
	shortnose sturgeon	zone of passage
	shortnose sturgeon	spawning, non-mobile ELS, fry
	tessellated darter	juvenile and adult, or adopt shallow-slow guild
	dace	juvenile and adult, or adopt shallow-fast guild
	freshwater mussels	host fish (*deep slow and shallow slow guild*), and/or mussel HSI criteria
	macroinvertebrates	larvae
Reach 3	American shad	spawning and incubation, juvenile, adult
	shortnose sturgeon	spawning, non-mobile ELS, fry, juvenile, adult
	sea lamprey	spawning, or adopt shallow-fast guild
	walleye	spawning, fry, juvenile, adult
	tessellated darter	juvenile and adult, or adopt shallow-slow guild
	dace	juvenile and adult, or adopt shallow-fast guild
	white sucker	spawning, fry, juvenile, adult
	fallfish	spawning, fry, juvenile, adult
	freshwater mussels	host fish (*deep slow and shallow slow guild*), and/or mussel HSI criteria
	macroinvertebrates	larvae
*Reach 4**	*American shad*	*spawning and incubation*
	American shad	*juvenile, adult*
	sea lamprey	*spawning and incubation*
	white sucker	*spawning, fry, juvenile, adult*
	fallfish	*spawning, fry, juvenile, adult*
	walleye	*juvenile, adult*
	tessellated darter	*juvenile and adult, or adopt shallow-slow guild*
	dace	*juvenile and adult, or adopt shallow-fast guild*
	freshwater mussels	*host fish (deep slow and shallow slow guild), and/or mussel HSI criteria*
	macroinvertebrates	*larvae*
	shortnose sturgeon	*Overwintering juvenile, overwintering adult*
*Reach 5**	*freshwater mussels*	*To be determined based on results of mussel survey in fall of 2013 in consult with MDFW and MA Natural Heritage*

*Notes: * Reaches 4 and 5 will be studied subsequent to further studies and agency consultation.*
Sea lamprey HSI curves may be updated contingent on the results of the Study 3.3.15.

Table 3.3.1-2: Mussel Species Potentially Found in the Study Area and their Preferred Habitat and Host Fish.

Mussel Species	Preferred Habitat	Host Fish
Yellow Lampmussel*	It has been found in shallow water and areas more than 30 feet deep, usually in slow to moderate flow conditions. Within its core range in Massachusetts, it exhibited a distinct preference for sand and fine gravel substrates, and it was proportionately more abundant in shallow sandbars than it was in nearby areas that were deeper and had a rocky or muddy substrate.	White perch; yellow perch; possibly striped bass; potential species include banded killifish, chain pickerel, white sucker, smallmouth bass, largemouth bass
Eastern Elliptio	Habitat generalist. The species has no clear preference for substrate: it is found in clay, mud, sand, gravel, and cobble bottoms. Like most species, it is less common in the areas of rivers where substrate is largely boulder and bedrock. May thrive in areas where habitat has been greatly modified or where pollution is moderate to severe, suggesting that the species is tolerant to many of the stressors that limit the distribution and abundance of other species.	White perch; yellow perch; American eel; alewife; blueback herring; threespine stickleback; banded killifish; white sucker; pumpkinseed; redbreast sunfish; black crappie; largemouth bass; smallmouth bass; brook trout; lake trout; mottled sculpin
Alewife Floater	Exists in small streams and large rivers, without clear preference for substrate, depth or flow conditions. Its habitat use and population density seems to be more strongly tied to where its host fish are likely to spawn or congregate.	American shad; alewife; blueback herring; possibly striped bass
Eastern Floater	The eastern floater is found in a wide variety of habitats. Appears to prefer deeper areas and silt and mud substrates, indicative of lower velocity areas.	Generalist: white sucker; carp; threespine stickleback; pumpkinseed; bluegill
Eastern Pondmussel*	The eastern pondmussel inhabits a wide variety of habitats in the southern part of the watershed. It exhibits no distinct preference for substrate, depth or flow conditions.	Unknown: anadromous or coastal
Triangle Floater	The triangle floater is most common in flowing water, where is occupies a wide range of substrate and flow conditions. Preferred habitats include low-gradient river reaches with sand and gravel substrates and with low to moderate water velocities.	Common shiner; blacknose dace; longnose dace; pumpkinseed; fallfish; slimy sculpin; white perch; white sucker; largemouth bass

*Notes: * indicates MA state-listed species. Source: Nedeau, 2008.*

Task 2: Field Data Collection

The second phase will quantify habitat-discharge relationships for selected species and lifestages in the study area, using standard PHABSIM data collection and flow modeling procedures (Bovee, 1982; Bovee *et al*., 1998). The modeling approach dictates what field data collection is necessary as explained below.

Data Collection in Reaches 1, 2, and 4 (1-D modeling)

A 1-D model approach using PHABSIM is suitable for Reaches 1[29], 2, and 4. A 1-D modeling approach will be based on hydraulic data developed from cross-sectional depth, velocity, and substrate measurements following Milhouse et al. (1989), using PHABSIM for Windows (V 1.5.1), developed by the USFWS and distributed by the USGS Fort Collins (CO) Science Center.

The location of each transect will be field blazed with flagging or other appropriate means. Each study site and cell boundary will be mapped sufficiently to quantify the area represented by each transect. The transect headpin and tailpins will be located at or above the top-of-bank elevation, and secured by steel rebar or other similar means. Measuring tapes accurate to 0.1 ft will be secured at each transect to enable repeat field measurements to occur at specific stream loci[30]. Stream bed and water elevations tied to a known datum will be surveyed to the nearest 0.1 ft using standard optical surveying instrumentation and methods.

Depth, velocity, and substrate data will be gathered at intervals (verticals) along each transect. Each vertical will be located to the nearest 0.1 ft wherever an observed shift in depth or substrate/cover occurs. Between 20 and 99 verticals per transect will be established as necessary on each transect. Verticals will be positioned so that no more than 10% of the discharge passes between any pair, to enhance hydraulic model calibration. A staff gage will be located in each study site, and monitored at the beginning and end of each set of hydraulic measurements to verify stable flow during measurements. If flow is found to be insufficiently stable, the related data will be discarded and re-measured once stable flow is established.

Mean column velocity will be measured to the nearest 0.1 ft/second with either a calibrated electronic velocity meter mounted on a top-setting wading rod, or alternatively an Acoustic-Doppler Current Profiler (ADCP) transducer. In water less than 2.5 ft depth, velocity measurements will be made at 0.6 of total depth (measured from the water surface); at greater depths, paired measurements will be made at 0.2 and 0.8 of total depth and averaged. At transects portraying mussel habitat (determined in consultation with MDFW), bottom velocity measurements will also be collected, or simulated using the IFG4 program in PHBASIM which facilitates modeling "nose" velocities (*i.e*. velocities occurring at the depth at which a species/lifestage is known to occupy).

Each calibration flow will be provided by scheduled releases from the Project via unit operation or in the case of the bypass reach through gate or fishway flow settings. Turbine and gate rating curves, USGS gages, and study-site field gaging will be collectively used to estimate each calibration flow release. Flow input from Fall River at the time of data collection will be accounted for by manually gaging. These data are added to the real-time discharge from the dam to define the net calibration flow passing through the study sites. Manual gaging will be accomplished using standard streamflow measurement techniques in which cellular depth and velocity measurements are collected across a transect and summing the measurements to calculate a flow in cfs.

[29] A 2-D model may be required for a portion of the uppermost section of the bypass reach if specific habitat targets are identified in this locale and modeling is deemed feasible.
[30] Supplemental transects may be located as needed to record water surface and bed elevation data at hydraulic controls to establish backwatering parameters necessary for hydraulic modeling.

The 1-D hydraulic model will be developed from measurements gathered at a minimum of three calibration flows (low, intermediate, high) to facilitate extrapolation of hydraulic data across the range of interest (see table below). To accomplish calibration, a full set of depth, velocity and water surface elevation (WSEL) data will be gathered at each transect at the intermediate flow, and WSEL will be measured at each transect for the low and high flows to calibrate the hydraulic models. At transects with complex hydraulics such as riffles, and/or sites with unusual backwatering or eddy effects, supplemental velocity data may also be gathered at the low calibration flow. This will be determined in the field on a case-by-case basis.

For the 1-D model, each calibration flow should ideally be broadly separated to provide a suitable stage-discharge curve for the hydraulic model. The general rule of thumb is the hydraulic model, and hence depths and velocities, can be extrapolated from 40-250% of any given calibration (measured) flow. Thus, the following calibration flows and associated flow ranges can be evaluated in the 1-D and 2-D hydraulic models. The calibration flow targets are listed below.

Reach	Model type	Approximate calibration flow (CFS)[31]	Approximate Extrapolated flow range (CFS)	WSEL	Velocity
1 and 2	1-D	120	50-300 cfs	X	*
1 and 2	1-D	700	280-1,750	X	X
1 and 2	1-D	4,000	1,600-10,000	X	
1 and 2	2-D**	120-4000[32]	50-10,000 cfs	120 cfs-5000 cfs	X[33]
3	2-D	2,500-9,000 cfs	1,430-22,500 cfs	1,430 cfs-22,500 cfs	X[34]
4	1-D	2,000 cfs	800 – 5,000 cfs	X	
4	1-D	6,000 cfs	2,400 – 15,000 cfs	X	X
4	1-D	15,000 cfs	6,000 – 37,500 cfs	X	

**supplemental velocity sets may be required at some complex transects as determined by hydraulic modeler*

***if 2-D modeling option is required in portions of these reaches, pending site visit and consultation with hydraulic modeler*

Data Collection in Reach 3 (2-D Modeling)

A two dimensional (2-D) approach will best represent hydraulics in Reach 3 due to the complex channel characteristics and hydraulics. A 2-D model is also being considered for the upstream portion of Reach 1 and the downstream portion of Reach 2.A final decision on the application of 2-D modeling will be based on a study site visit and consultation with a hydraulic modeler.

[31] Reach 5 will be determined at a later date.
[32] The calibration flow(s) chosen for this reach will largely depend on the ability (and safety) of the field crew to collect data in this reach. At various flows there may be areas that are too shallow or fast to safely boat but still too deep or fast to wade. As such, spatially incomplete calibration sets may be collected for portions of this reach.
[33] At least one velocity dataset across the reach will be collected, as field conditions allow.
[34] At least one velocity dataset across the reach will be collected, as field conditions allow. The actual flow chosen will depend on the July site visit results and safety/boatability in the field. For Reach 3, calibration flows may be provided from Turners Falls Dam, or through a combination of Turners Falls Dam and Cabot Station to evaluate the backwater influence.

For the 2-D model, two calibration flows will be employed; the exact flows required are not critical but should represent hydraulic conditions including both "typical" generating from Cabot Station and an intermediate discharge through the study reach. This allows the modeler to evaluate the directionality of flow vectors under different flow inputs both from the bypass reach as well as from station discharge. The need for any additional calibration flow data will be evaluated on a case-by-case basis. A two dimensional substrate map will be developed from recently collected information and supplemented with additional field work. Substrate will be categorized based on substrate size codes specified within the HSI substrate curves in Attachment A.

The 2-D model will be developed using a combination of terrain (LIDAR and/or 10m DEM, depending on availability) and bathymetric data. This will include a WSEL survey, and flow gaging at the inlet and/or outlet of the study site boundaries. To the extent possible, bathymetric data will be provisionally assembled from existing sources including past modeling, surveys, bridges, Project related information, and fishing/recreation maps. It is likely that additional bathymetric data will need to be collected to supplement the existing data coverage to create a fine scale mesh. These will be obtained through a combination of depth sounding and RTK-GPS (Real Time Kinematic), as required. In addition, it is expected that a high-level of bathymetric mapping will be obtained in the vicinity of the Cabot tailrace and existing fishway entrance as part of a computation fluid dynamic (CFD) model being developed (see Study No. 3.3.8 *Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays*).

Task 3: Hydraulic Modeling (Reaches 1-4)

Model boundary conditions (input values for generation at Cabot and Station No. 1, river discharge, spill at Turners Falls Dam, and tributary inflows) will be obtained from observed flow and release records. Modeling scenarios will be developed and run in "steady state" mode to produce data required to support the PHABSIM analyses including water profiles, wetted area, depth and velocity at flow increments of interest.

1-D hydraulic modeling will be accomplished by calibration (correlating each surveyed WSEL set with discharge to develop a stage-discharge relationship for each transect). PHABSIM uses STGQ, MANSQ and WSP models to predict water surface elevations at various calibration flows. It then uses the VELSIM model to predict cellular water velocities based on the calibration dataset(s). The model is calibrated by comparing simulated hydraulics to empirical measurements taken at the calibration flows. Coefficients such as relative stream channel roughness (*commonly referred to as Mannings n*) are then iteratively adjusted as needed to optimize model accuracy across the full flow range. Once this relationship is established, the model then calculates additional WSELs at other flow increments, and adjusts velocities obtained at calibration flows to other flow increments of interest for which defined water stages have been calculated.

2-D hydraulic modeling, while similar in many ways to 1-D modeling, requires an initial phase of developing and testing of the model grid-space and arrangement. The process is iterative, with a goal of finding the best balance of model stability, accuracy, and performance. This will occur at a single test condition that represents a fairly common flow, including representative hydraulics, and has sufficient supporting input data (*e.g.*, most observations).

Following development and testing of the model grid, the model will then be calibrated and verified. The most common approach for calibration is to provide a discharge value as the upstream boundary condition while the downstream boundary relies on the measured WSEL. Measured WSELs at the survey transects will be used to directly calibrate to a specific steady flow analysis scenario. Calibration is achieved by adjusting the resistance terms in the model to provide predicted WSELs that best match measured WSELs, for a given discharge. Model verification will be conducted by running the calibrated model for other measured flow conditions and comparing the model-predicted results to the independent measured values.

Task 4: Habitat Modeling (Reaches 1-4)

Once the hydraulic model is calibrated, habitat suitability at each flow increment of interest will be quantified by combining the HSI and hydraulic model data using the HABTAE and supporting programs within PHABSIM. These output units of Weighted Usable Area (WUA) for each transect at each flow increment, for each species and lifestage. WUA is an abstract habitat suitability index generated from units of square feet of optimal habitat available per 1,000 feet of represented stream length. The habitat suitability-flow curves across the flow range for all transects in a given study site are then weighted and summed at the study reach level, according to actual linear stream length that each site represents, as mapped in the field.

Task 5: Habitat Time Series (Reaches 3 and 4)

The WUA information (habitat versus flow) will be merged with HEC-ResSim model results (see Study No. 3.8.1, *Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation*) for Reaches 3 and 4. Specifically, FirstLight will use the hourly discharge hydrograph(s) below Cabot Station from the HEC-ResSim model. The discharge hydrograph from the model will be merged with the Weighted Usable Area versus flow curves from the IFIM study to yield habitat time series (Figure 3.3.1-5). All habitat time series analysis will rely on flow data from the baseline model, which will be used as a basis of comparison. Habitat time series will be developed from any alternative modes of operation using the HEC-ResSim discharge data, which again will be compared to the baseline model habitat time series. The alternative operation scenarios will be developed in consultation with the relicensing stakeholders after the initial study results have been completed.

Task 6: Persistent Habitat Analysis and Mapping (Reach 3) and Dual Flow Analysis (Reach 4)

The objective of Task 6 is to evaluate the relationship between short-term hydrologic variability (i.e., peaking flows) and immobile aquatic species' habitat. "*Immobile aquatic species*" are those species and/or life stages that are considered unable to volitionally relocate to suitable locations in response to a typical peaking cycle, or are weak swimmers that may need to expend significant bioenergetics or risk of predation to do so (*e.g.*, aquatic macroinvertebrates, mussels, incubating eggs, early fry, weak swimmers, *etc.*). A persistent habitat analysis will be conducted for study reaches modeled with a two-dimensional model. A dual flow analysis will be conducted for Reach 4 (modeled with a one-dimensional model).

A persistent habitat analysis consists of first identifying "quality" habitat areas (*i.e.*, a model node's combined habitat suitability ≥ 0.5) at each modeled base flow, and then finding overlapping areas of quality habitat that persist at various low and high flow pairs (e.g., 1,000 cfs and 5,000 cfs). "Persistent" habitat is then calculated for various flow pairs on a node-by-node basis, where a node is marked as persistent habitat for that flow pair if the high and low flows (as well as any flows in between) are considered quality habitat. The analysis results can be mapped to visualize what areas provide consistently good habitat throughout the target flow range. The results from this task will include a low/high flow habitat matrix for each target species/life stage (Table 3.3.1-3) and a series of maps depicting persistent habitat for a variety of flow ranges covering expected operation flows (Figure 3.3.1-6).

A "dual flow" analysis is similar to persistent flow analysis but is the term applied to the 1-D model. It calculates the quantity of habitat present over paired base flow and peak flows across a range of scenarios, such as those that may be expected during a minimum flow/peaking flow hydroelectric operation. Dual flow results will be presented on a transect-by-transect basis. Deliverables will include dual flow habitat tables (similar to persistent habitat tables) for each study transect. Composite dual flow results may also be presented, based on the total dual flow habitat available at each transect.

Task 7: Study Report

A draft report will be prepared for study team review and comment, documenting methods and results. The report will quantify flow/WUA relationships for applicable species and lifestages in each study reach. WUA and supporting hydraulic data will be presented in graphic and tabular form, along with an analysis of trends in the data, and documentation of study team consultation. Appendices will also include cross-sectional survey data and reference photographs of study sites. The report will be finalized following receipt of input from the study team. Raw field data and model output data will be made available upon request.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The estimated cost for the study outlined in this plan is approximately $200,000-$250,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight is proposing to commence this study before the FERC Study Plan Determination is issued, which is due by September 12, 2013. In developing this study plan, meetings were held with the state and federal resource agencies including NOAA, USFWS, MADFW, and MADEP to help jump-start the study planning.

However, to ensure all interested parties have input on the study plan, a draft of this study plan was provided to all parties on the mailing list and a meeting was held to solicit and address issues on the plan on April 16, 2013 at the Northfield Mountain Visitor Center (99 Millers Falls Road, Northfield, MA). A subsequent draft was provided to the working group on May 30, 2013. A site visit is scheduled with interested parties for July 2013 in order to select study sites and cell boundaries. Additional stakeholder consultation will occur as this and other relicensing studies progress.

The accelerated schedule for this study is listed below.

TASK	COMPLETION DATE
Select study sites and cell boundaries	July, 2013
Collect hydraulic and bed profile data	August, 2013
Complete modeling (Reaches 1-3)	2013
Issue draft report (Reaches 1-3)	2013
Scope remaining work with stakeholders	November, 2013
Issue interim final report (Reaches 1-3)	December 31, 2013
Complete work on Reach 4 and 5, as necessary	2014, in accordance with ILP

Literature Cited

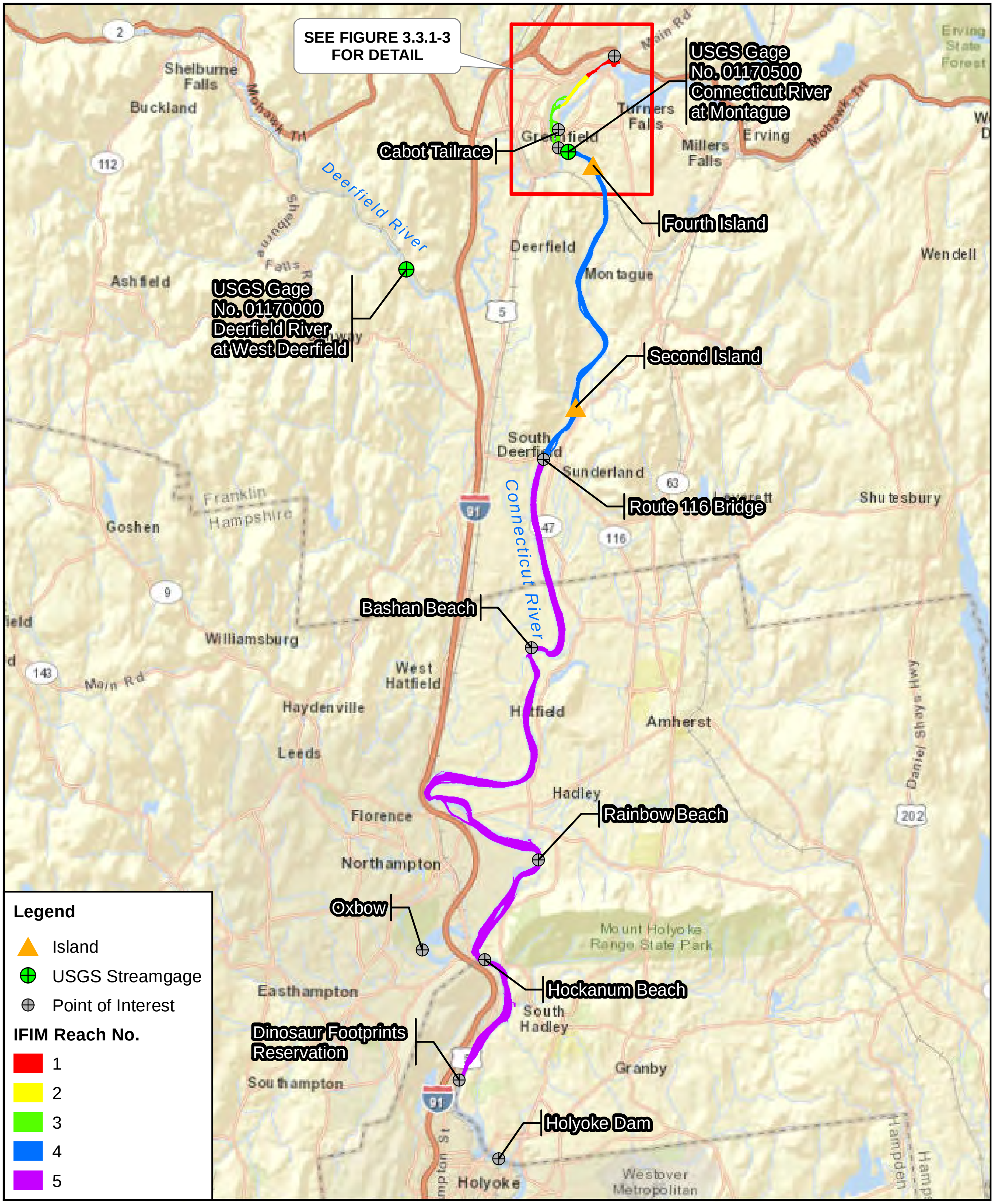
Bovee, K.D. (1982). *A guide to stream habitat analysis using the instream flow incremental methodology*. (Office of Biol. Service FWS/OBS-82-26). Washington, DC.: USFWS, U.S. Dept. of Interior.

Bovee, K.D., Lamb, B.L., Bartholow, J.M., Stalnaker, C.B., Taylor, J. & Henriksen, J. (1998). S*tream habitat analysis using the instream flow incremental methodology*. (Biological Resources Division Information and Technology Report USGS/BRD-1998-0004/ viii). U.S. Geological Survey,

Milhouse, R. T., Updike, M. A, & Schneider, D. M.. (1989). *Physical habitat simulation system reference manual: version 2, Instream flow information paper 26* (Biological Report 89(16)). Washington, D.C.: U.S. Fish and Wildlife Service.

Table 3.3.1-3: Example of a typical persistent habitat or dual flow habitat matrix

	Generation Flow (cfs)													
Minimum Flow (cfs)	2,000	3,500	5,000	7,500	10,000	15,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	86,000
2,000	**144,797**	144,797	144,797	144,797	144,797	141,917	123,412	51,975	22,024	9,953	2,244	2,244	2,244	2,244
3,500		**185,653**	185,653	185,653	185,653	182,772	164,268	90,944	60,993	50,809	36,878	12,923	8,355	5,797
5,000			**205,330**	205,330	205,330	202,449	183,944	110,621	80,670	67,350	49,507	23,477	18,908	16,351
7,500				**282,747**	282,747	279,867	261,362	188,038	154,263	129,637	107,840	78,039	65,696	59,689
10,000					**577,085**	574,204	555,699	482,376	441,548	395,558	358,637	286,794	237,594	218,426
15,000						**1,465,467**	1,446,962	1,371,294	1,304,578	1,214,177	1,127,012	1,011,489	835,362	775,405
20,000							**2,022,046**	1,941,371	1,864,518	1,724,558	1,577,015	1,399,627	1,138,275	1,060,982
30,000								**2,649,183**	2,560,652	2,374,400	2,144,559	1,901,348	1,562,157	1,444,265
40,000									**2,973,742**	2,774,018	2,528,802	2,245,387	1,867,061	1,717,777
50,000										**3,030,923**	2,777,884	2,481,909	2,097,652	1,936,262
60,000											**2,949,583**	2,650,148	2,255,762	2,094,373
70,000												**2,822,902**	2,417,072	2,252,212
80,000													**2,521,060**	2,352,468
86,000														**2,428,418**



FIRSTLIGHT POWER RESOURCES

IFIM STUDY

Figure 3.3.1-1: Proposed Instream Flow Study Reaches

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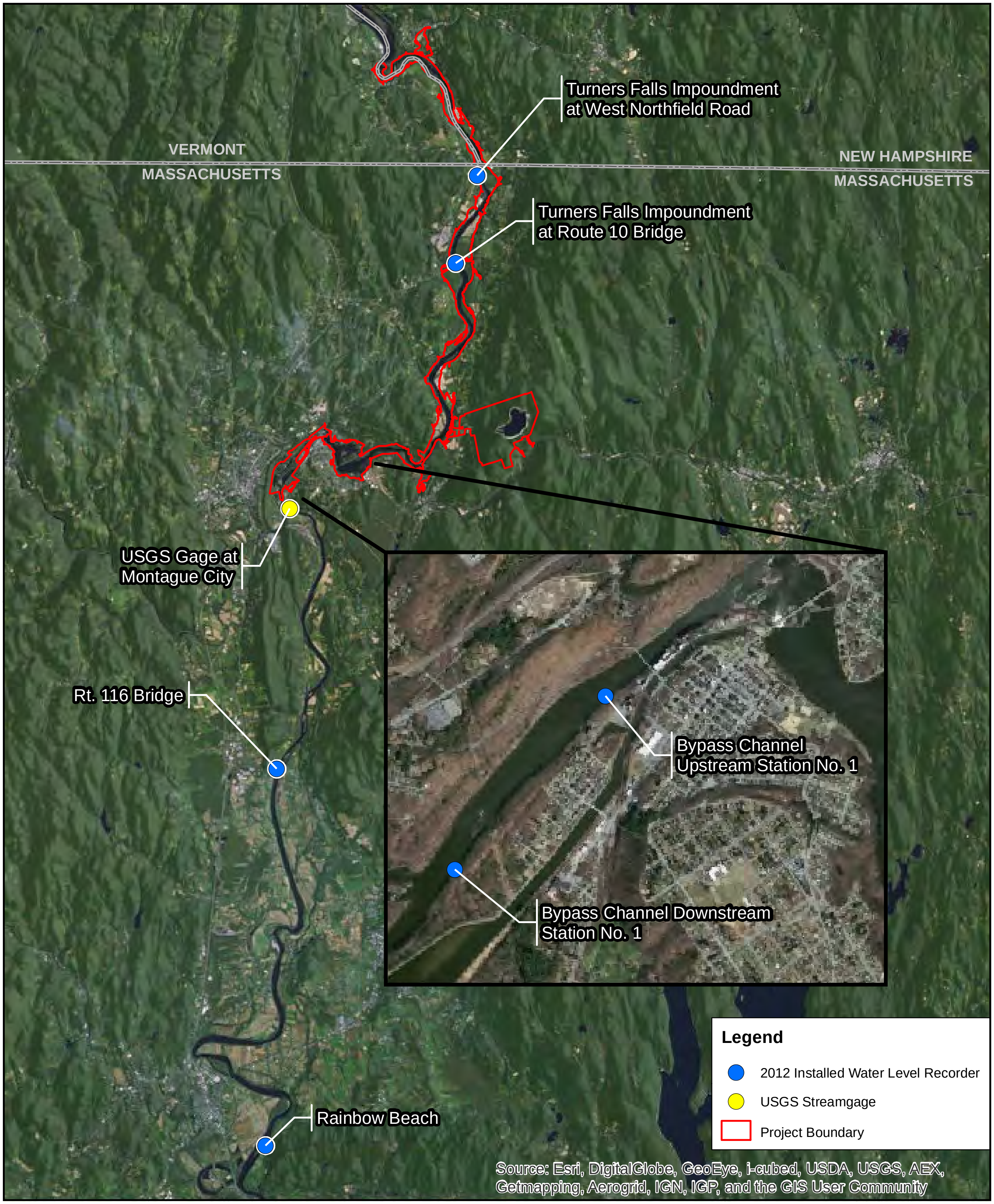

FirstLight Power Resources
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

0 1.5 3 4.5 6 Miles

Figure 3.3.1-2
2012 Installed Water Level Recorder Locations

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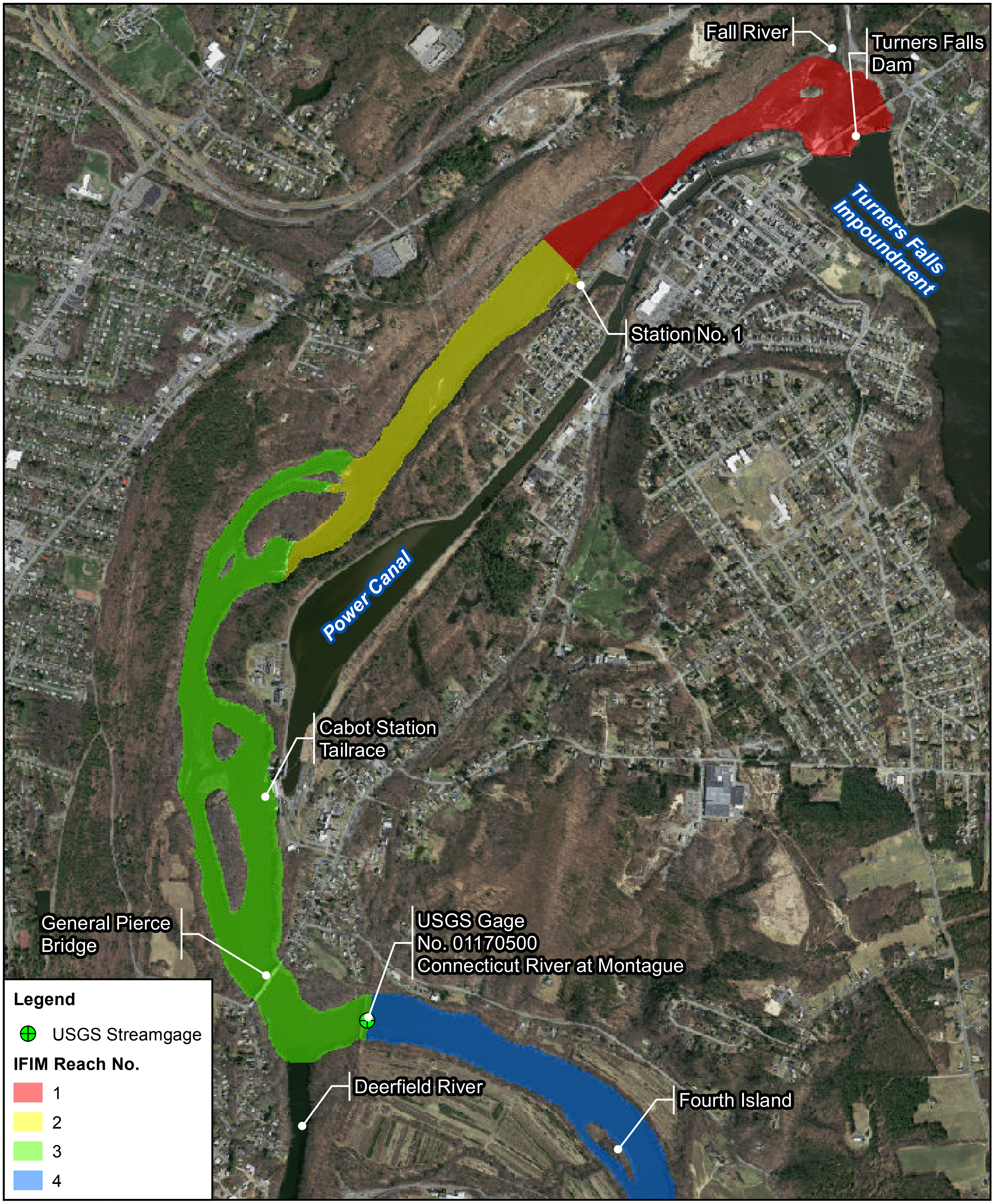

FirstLight Power Resources
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

IFIM STUDY

0 0.25 0.5 1 Miles

Figure 3.3.1-3: Proposed Instream Flow Study Reaches - Bypass Reach Inset

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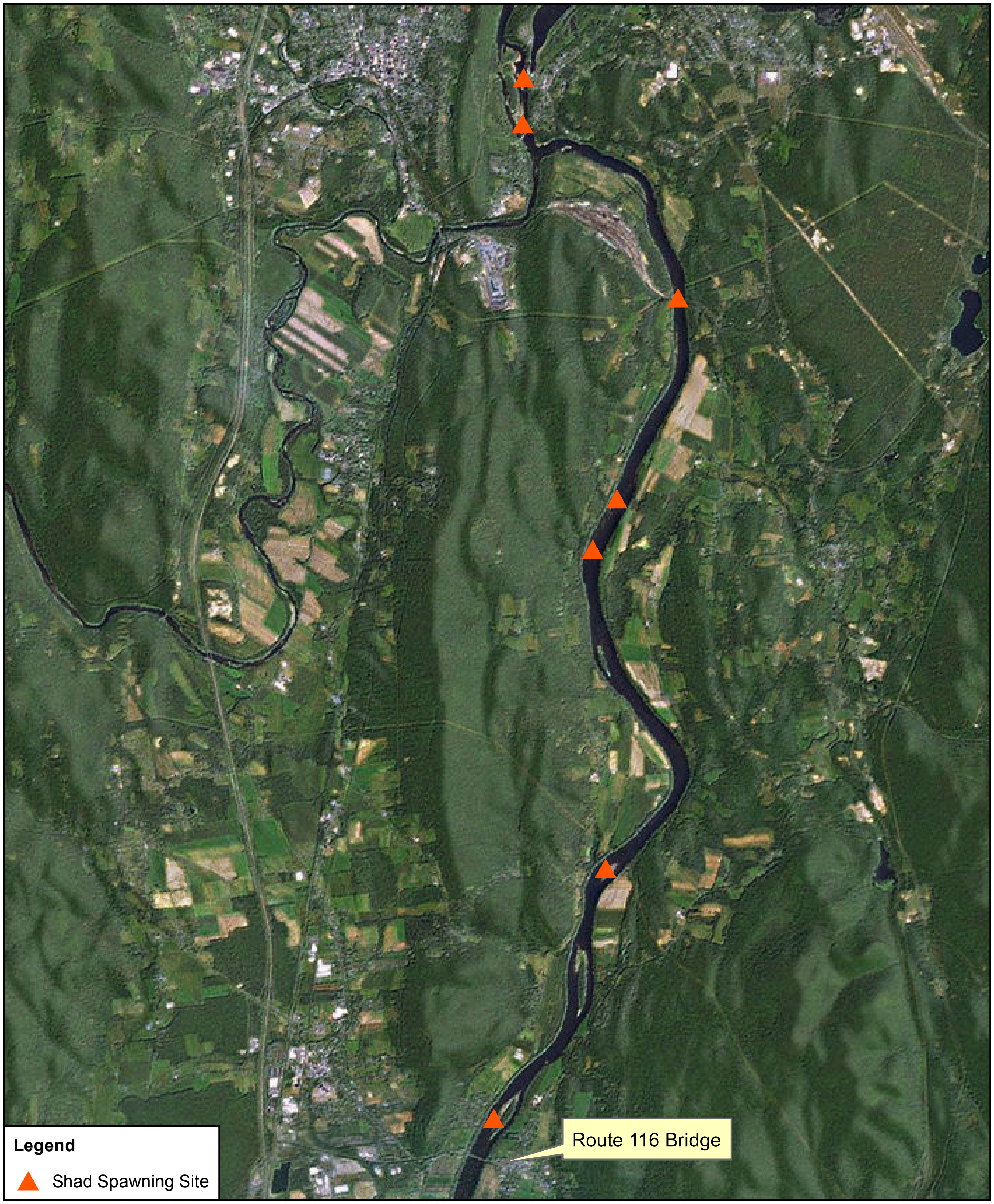


FirstLight Power Resources GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

IFIM STUDY

0 0.25 0.5 1 Miles

Figure 3.3.1-4
American Shad Spawning Sites
Layzer (1972) & Kuzmeskus (1975)

Path: W:\gis\maps\IFIM\ShadSpawn.mxd

Figure 3.3.1-5: Habitat Time Series Schematic

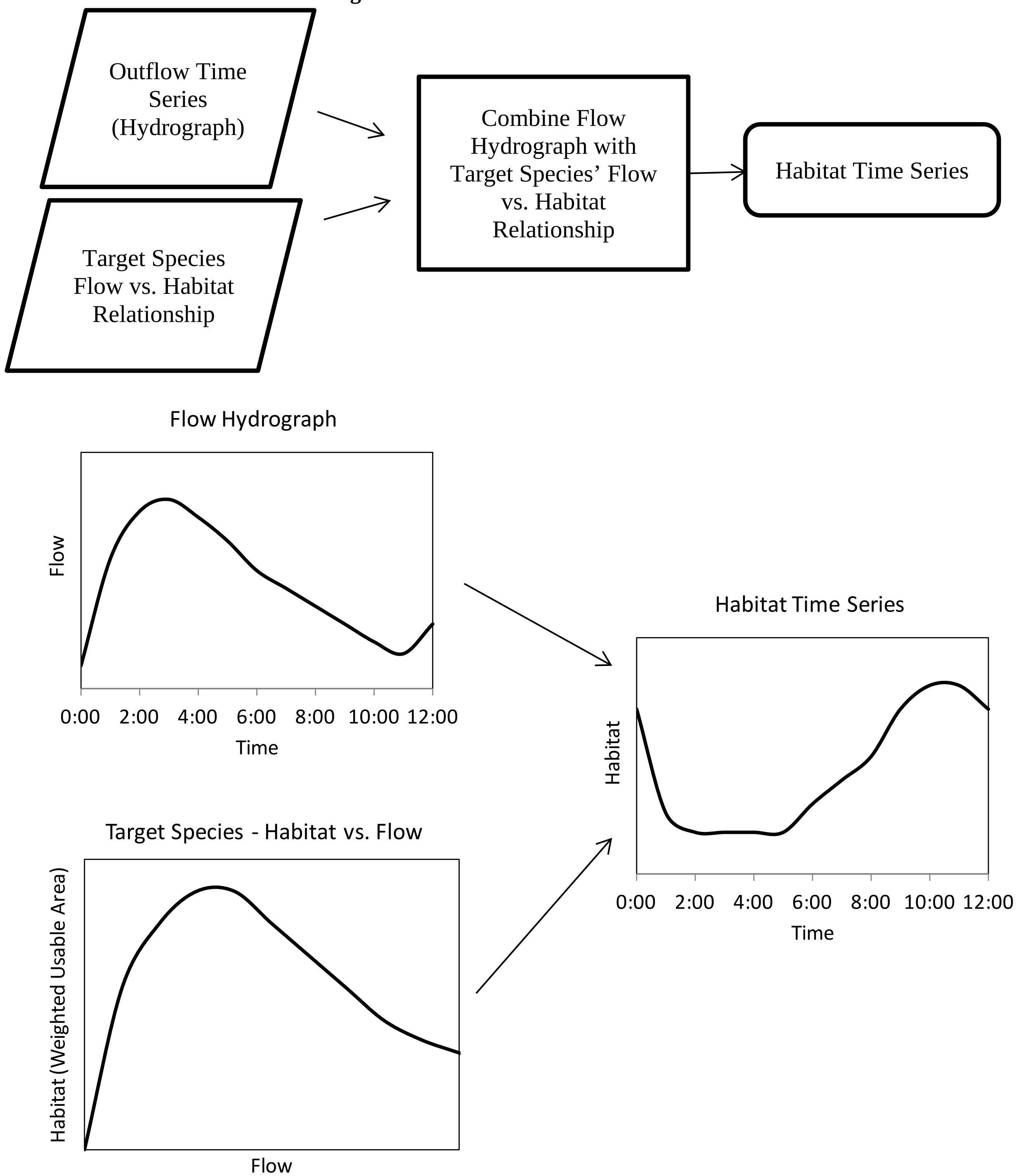
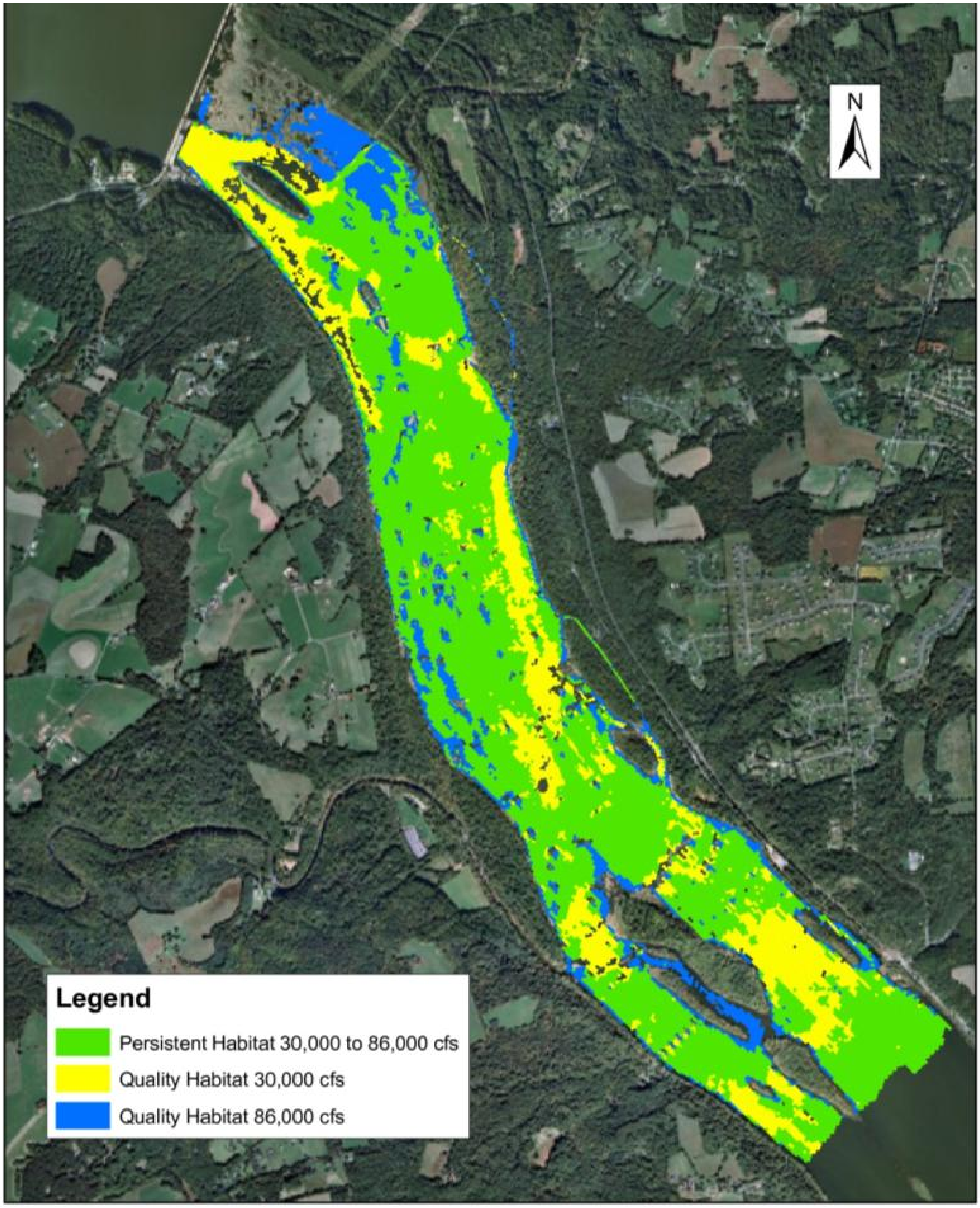


Figure 3.3.1-6: Example Persistent Habitat Map



ATTACHMENT A: PROPOSED HABITAT SUITABILITY INDEX CURVES

Habitat Suitability Criteria references for the Turners Falls Instream Flow Study.

Species	Lifestage	HSC source reference
American shad	Spawning	Hightower et al., 2012
	Juvenile	Stier and Crance, 1985
	Adult	Stier and Crance, 1985
Shortnose sturgeon	Spawning	NOAA, 2013
	Egg/non-mobile larvae	NOAA, 2013
	Fry	NOAA, 2013
	Juvenile	NOAA, 2013
	Adult	NOAA, 2013
Fallfish	Spawning	Gomez and Sullivan, 2007
	Fry	Gomez and Sullivan, 2007
	Juvenile	Gomez and Sullivan, 2007
	Adult	Gomez and Sullivan, 2007
Longnose dace	Juvenile	Gomez and Sullivan, 2000
	Adult	Gomez and Sullivan, 2000
White sucker	Spawning	Gomez and Sullivan, 2007
	Fry	Twomey, et al., 1984
	Juvenile/Adult	Twomey, et al., 1984
Walleye	Spawning	McMahon, et al., 1984 and Bozek et al., 2011
	Fry	McMahon, et al., 1984
	Juvenile	McMahon, et al., 1984
	Adult	McMahon, et al., 1984
Tessellated darter	Juvenile/Adult	PPL Bell Bend, 2012
Sea lamprey	Spawning	Kynard and Horgan, 2013
Macroinvertebrates	-	Gomez and Sullivan, 2000

Habitat Suitability Criteria References

Bozek, M.A., T. J. Haxton, and J. K. Raabe. 2011. Walleye and sauger habitat. Pp 133-197, *in* Biology, management, and culture of walleye and sauger, B. A. Barton, editor. 570 pages, American Fisheries Society, June 2011 ISBN: 978-1-934874-22-6.

Exelon. 2012. Instream flow habitat assessment below Conowingo Dam, Conowingo Hydroelectric Project, FERC Project No. 405. Prepared by Gomez and Sullivan Engineers and Normandeau Associates.

Gomez and Sullivan Engineers. 2000. Lamoille River Hydroelectric Project, FERC Project No. 2205. Instream flow and habitat study report. Prepared for Central Vermont Public Service Corp.

Gomez and Sullivan Engineers. 2007. Glendale Hydroelectric Project, FERC Project No. 2801. Final Report Bypass reach aquatic habitat and instream flow study.

Hightower, J.E., J. E. Harris, J. K. Raabe, P. Brownell, C. A. Drew. 2012 . A bayesian spawning habitat suitability model for American shad in southeastern United States rivers. Jour. of Fish and Wildl. Mngmnt. 3:2 p 184-198

Kynard B. & M. Horgan. 2013. Habitat suitability index for sea lamprey redds. Unpublished manuscript. 5 pp.

McMahon, T.E., J.W. Terrell, & P.C. Nelson. 1984. Habitat suitability information: Walleye. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.56. 43 pp.

National Oceanic and Atmospheric Administration (NOAA). 2013. Personal communication. May 7 and May 13, 2013. Jessica Pruden, Northeast Region Shortnose Sturgeon Recovery Coordinator, NOAA Fisheries, Gloucester, MA.

PPL Bell Bend, LLC. 2012. Bell Bend Nuclear Power Plant. IFIM and aquatic impact studies.

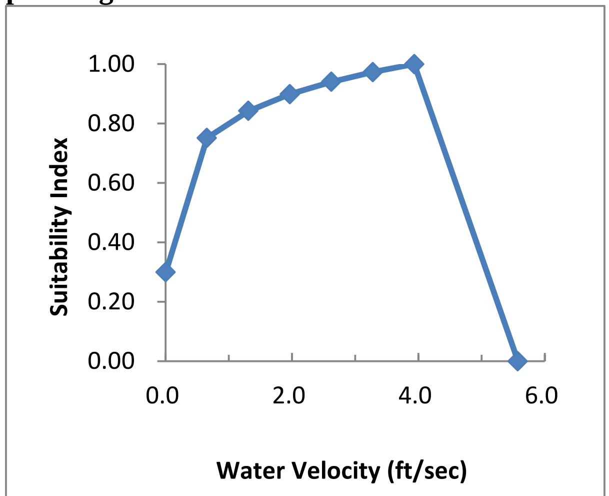
Stier, D.J., & Crance, J.H. 1985. Habitat suitability index models and instream flow suitability curves: American shad. United States Fish and Wildlife Service Biological Report 82(10.88).

Twomey, K.A, Williamson, K.L., & Nelson, P.C. 1984. Habitat suitability information: white sucker. U.S. Fish and Wildlife Service. Biol. Rep. FWS/OBS-82/10.64.

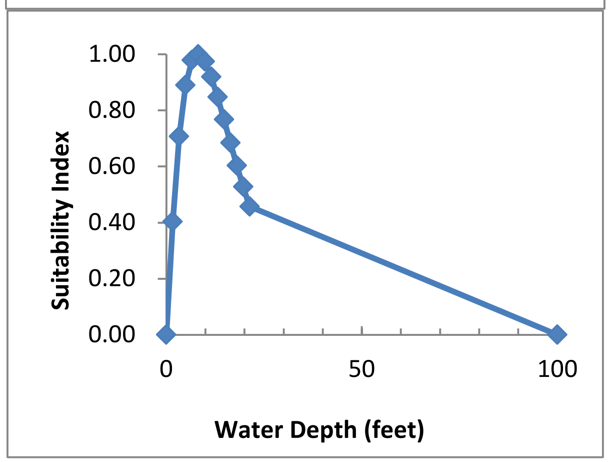
Species: American Shad
Lifestage: Spawning

Velocity

Velocity	SI Value
0.0	0.30
0.7	0.75
1.3	0.84
2.0	0.90
2.6	0.94
3.3	0.97
3.9	1.00
5.6	0.00

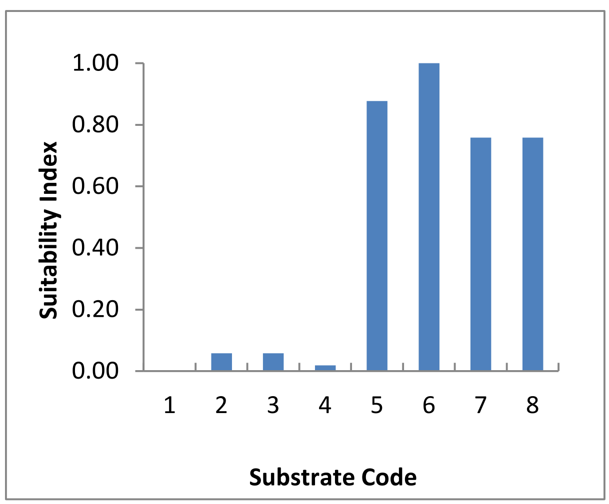


Depth (ft)	SI Value
0.0	0.00
1.6	0.40
3.3	0.71
4.9	0.89
6.6	0.98
8.2	1.00
9.8	0.97
11.5	0.92
13.1	0.85
14.8	0.77
16.4	0.68
18.0	0.60
19.7	0.53
21.3	0.46
100.0	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.06	Mud/soft clay
3	0.06	Silt
4	0.02	Sand
5	0.88	Gravel
6	1.00	Cobble/rubble
7	0.76	Boulder
8	0.76	Bedrock

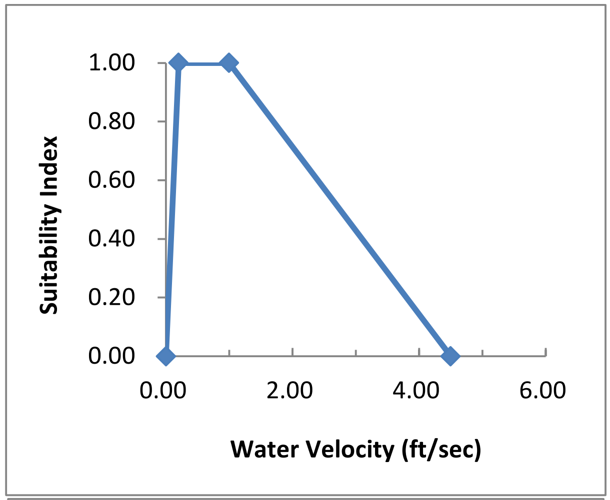


Source: Hightower et al, 2012

Species: American Shad
Lifestage: Juvenile

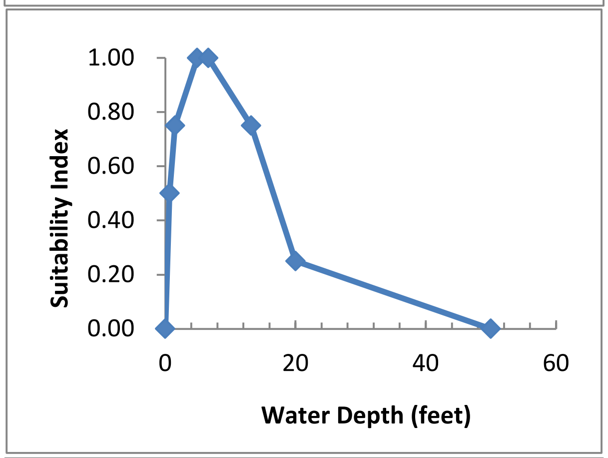
Velocity

Velocity	SI Value
0.00	0.00
0.20	1.00
1.00	1.00
4.50	0.00



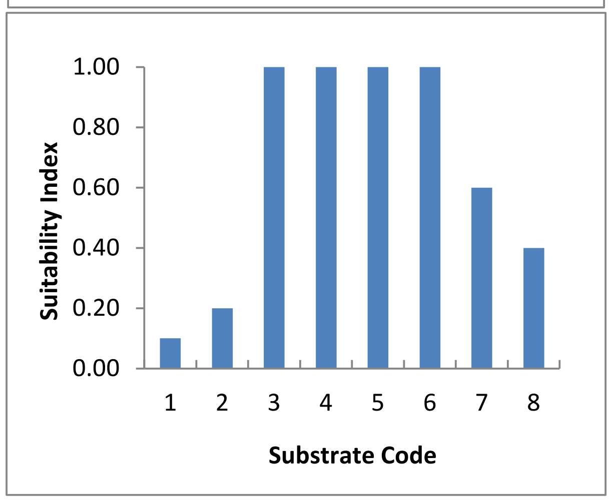
Depth

Depth	SI Value
0.00	0.00
0.66	0.50
1.50	0.75
4.90	1.00
6.60	1.00
13.20	0.75
20.00	0.25
50.00	0.00



Substrate

Substrate	SI Value	Type
1	0.10	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

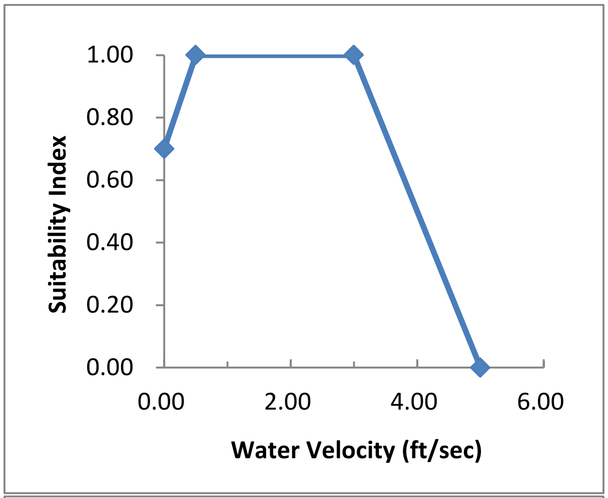


Source: Conowingo IFIM
Stier and Crance, 1985
Depth from Ross et al, 1993

Species: American Shad
Lifestage: Adult

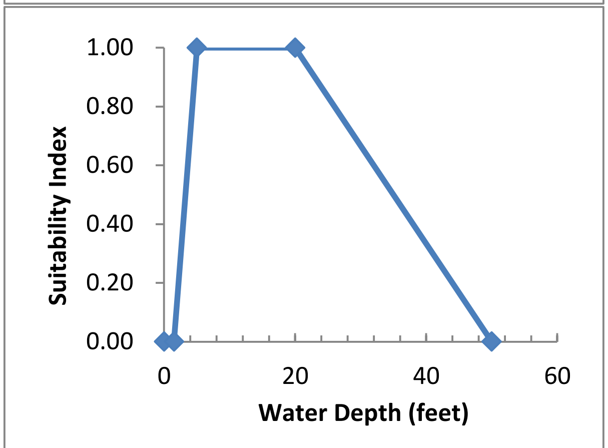
Velocity

Velocity	SI Value
0.00	0.70
0.50	1.00
3.00	1.00
5.00	0.00



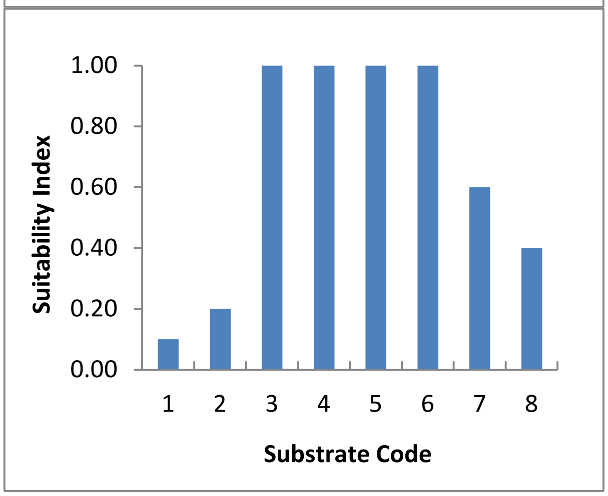
Depth

Depth	SI Value
0.00	0.00
1.50	0.00
5.00	1.00
20.00	1.00
50.00	0.00



Substrate

Substrate	SI Value	Type
1	0.10	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

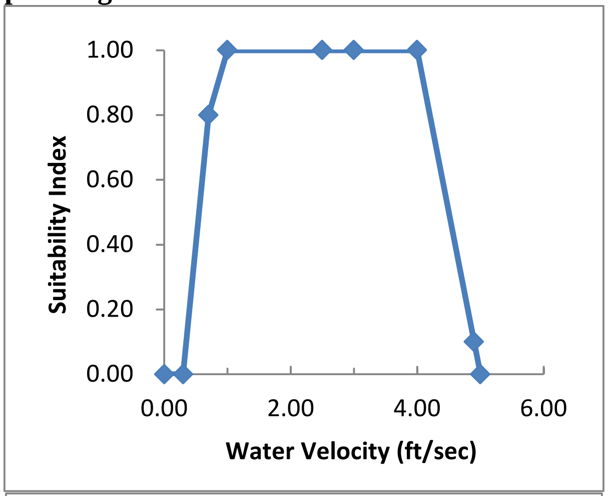


Source: Conowingo IFIM
Stier and Crance, 1985

Species: Shortnose Sturgeon
Lifestage: Spawning

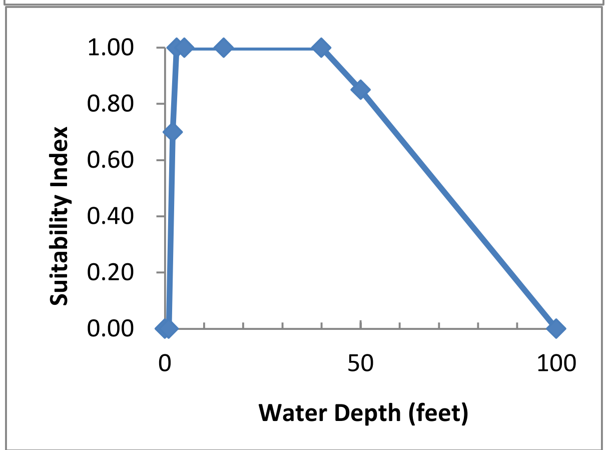
Velocity

Velocity	SI Value
0.00	0.00
0.30	0.00
0.70	0.80
1.00	1.00
2.50	1.00
3.00	1.00
4.00	1.00
4.90	0.10
5.00	0.00



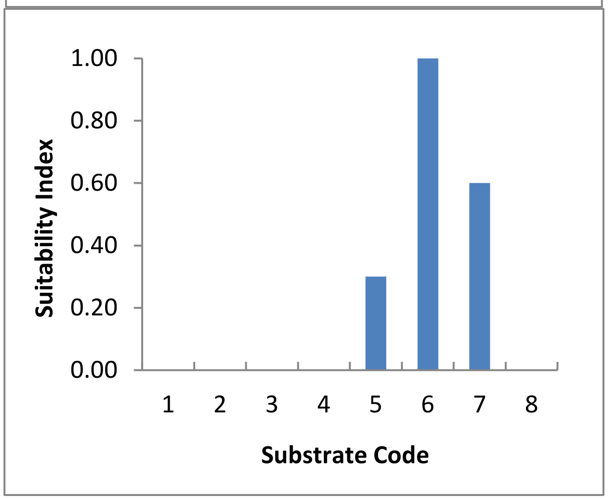
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
2.00	0.70
3.00	1.00
5.00	1.00
15.00	1.00
40.00	1.00
50.00	0.85
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.00	Sand
5	0.30	Gravel
6	1.00	Cobble/rubble
7	0.60	Boulder
8	0.00	Bedrock

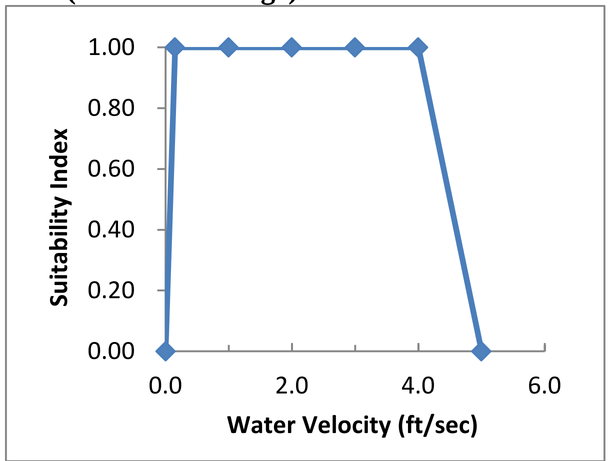


Source: Adapted from Conowingo IFIM by NOAA.

Species: Shortnose Sturgeon
Lifestage: Egg/ Embryo/larvae (non-mobile stage)

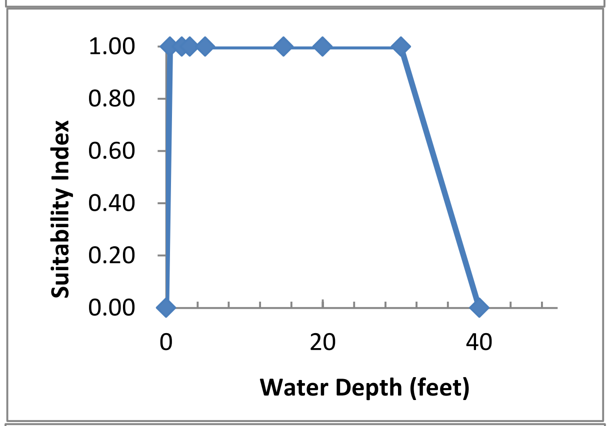
Velocity

Velocity	SI Value
0.00	0.00
0.15	1.00
1.00	1.00
2.00	1.00
3.00	1.00
4.00	1.00
5.00	0.00



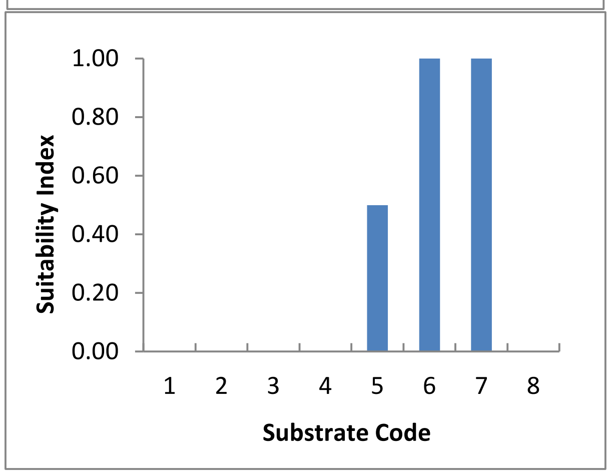
Depth

Depth	SI Value
0.00	0.00
0.50	1.00
2.00	1.00
3.00	1.00
5.00	1.00
15.00	1.00
20.00	1.00
30.00	1.00
40.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.00	Sand
5	0.50	Gravel
6	1.00	Cobble/rubble
7	1.00	Boulder
8	0.00	Bedrock

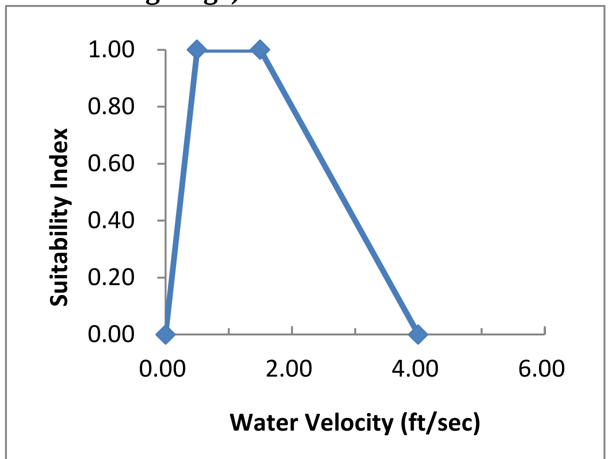


Source: NOAA 2013.

Species: Shortnose Sturgeon
Lifestage: Fry (post drift/ exogenous feeding stage) 16-57mm

Velocity

Velocity	SI Value
0.00	0.00
0.50	1.00
1.50	1.00
4.00	0.00



Depth

Depth	SI Value
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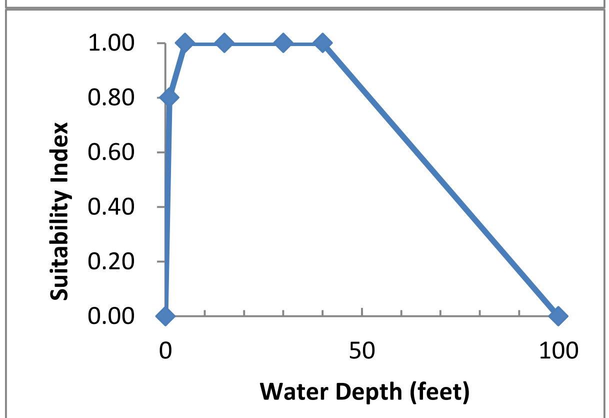
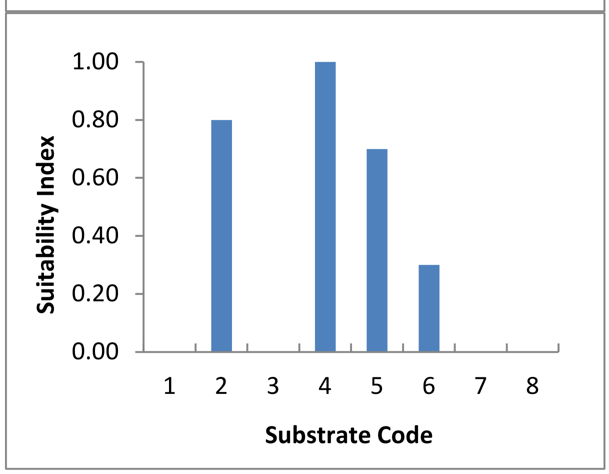
5.00	1.00
15.00	1.00
30.00	1.00
40.00	1.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.80	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	0.70	Gravel
6	0.30	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock

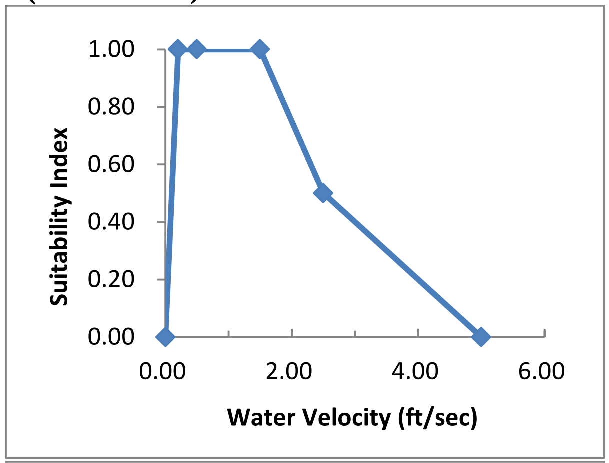


Source: Adapted from Conowingo IFIM by NOAA.

Species: Shortnose Sturgeon
Lifestage: Juveniles (60 - 650 mm)

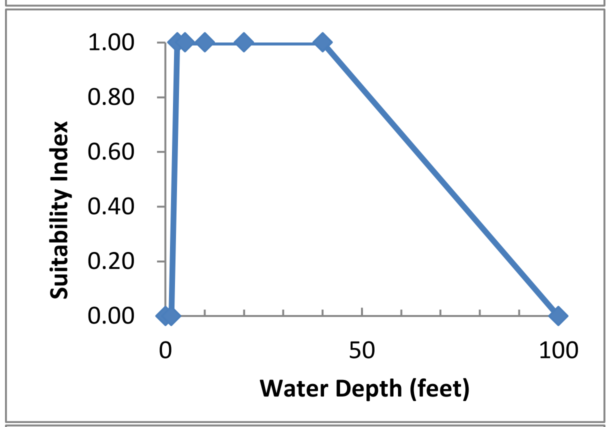
Velocity

Velocity	SI Value
0.00	0.00
0.20	1.00
0.50	1.00
1.50	1.00
2.50	0.50
5.00	0.00



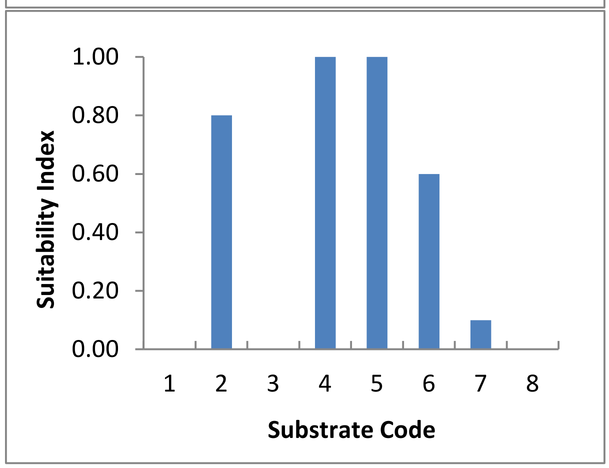
Depth

Depth	SI Value
0.00	0.00
1.50	0.00
3.00	1.00
5.00	1.00
10.00	1.00
20.00	1.00
40.00	1.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.80	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.60	Cobble/rubble
7	0.10	Boulder
8	0.00	Bedrock

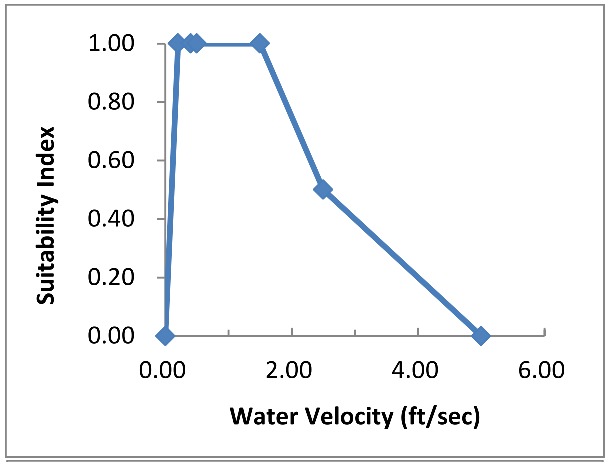


Source: Adapted from Conowingo IFIM by NOAA.

Species: Shortnose Sturgeon
Lifestage: Adults

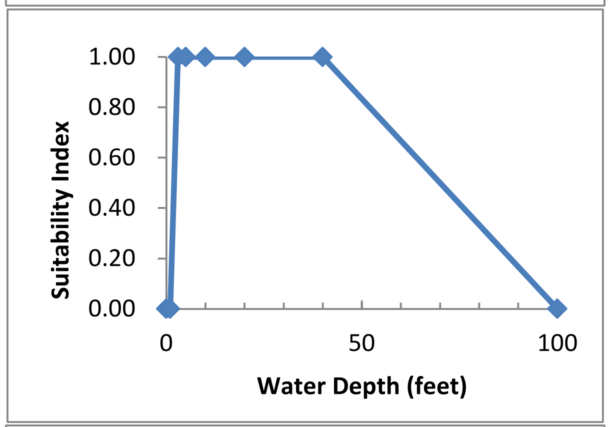
Velocity

Velocity	SI Value
0.00	0.00
0.20	1.00
0.40	1.00
0.50	1.00
1.50	1.00
2.50	0.50
5.00	0.00



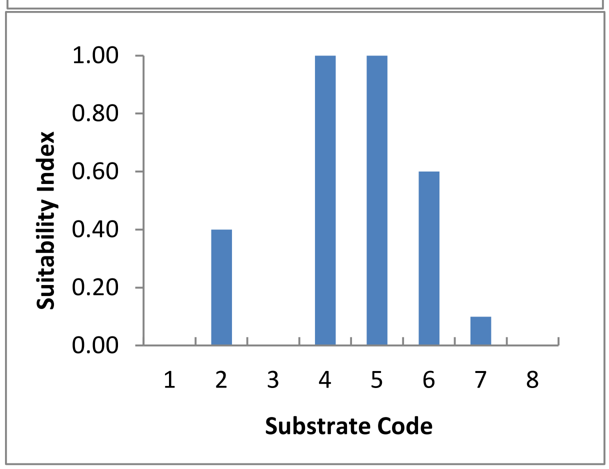
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
3.00	1.00
5.00	1.00
10.00	1.00
20.00	1.00
40.00	1.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.40	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.60	Cobble/rubble
7	0.10	Boulder
8	0.00	Bedrock

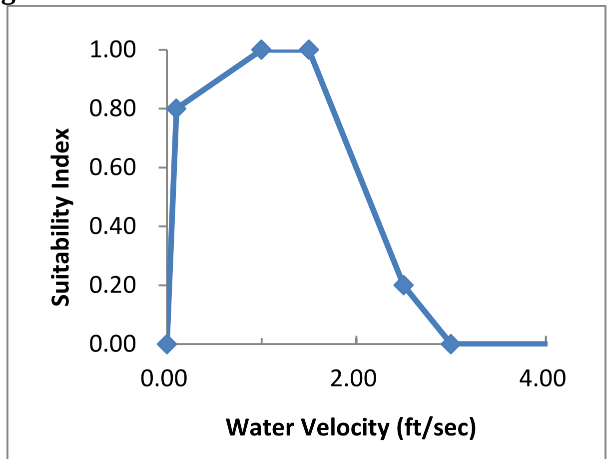


Source: Adapted from Conowingo IFIM by NOAA.

Species: Fallfish
Lifestage: Spawning and Incubation

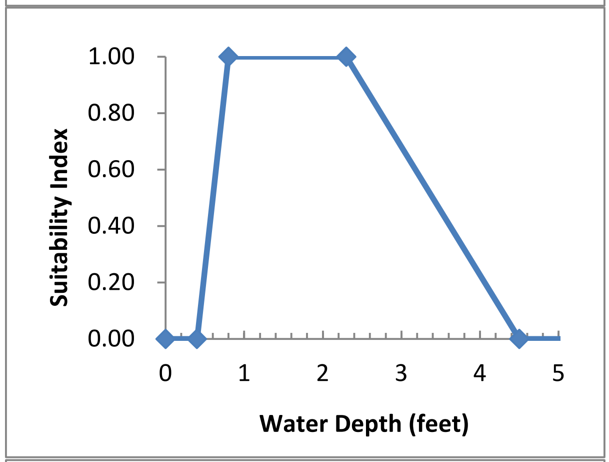
Velocity

Velocity	SI Value
0.00	0.00
0.10	0.80
1.00	1.00
1.50	1.00
2.50	0.20
3.00	0.00
100.00	0.00



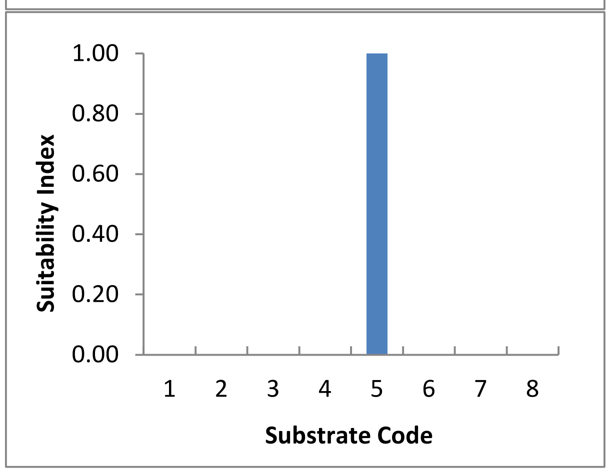
Depth

Depth	SI Value
0.00	0.00
0.40	0.00
0.80	1.00
2.30	1.00
4.50	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.00	Sand
5	1.00	Gravel
6	0.00	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock

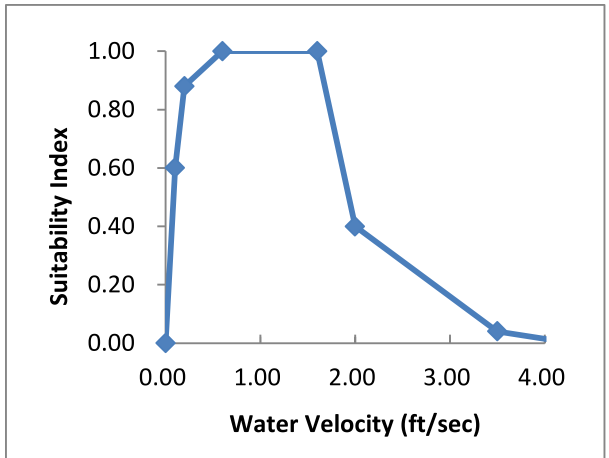


Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Fallfish
Lifestage: Juvenile

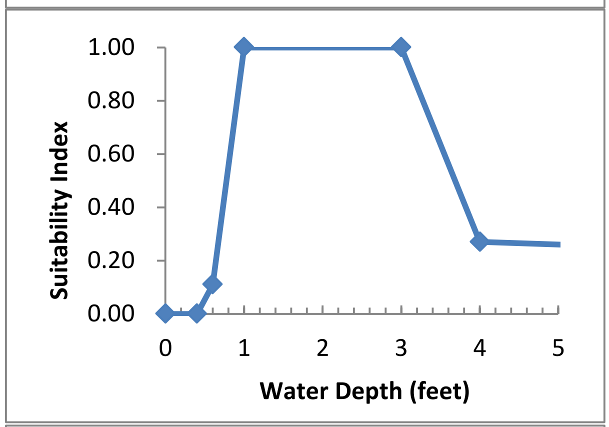
Velocity

Velocity	SI Value
0.00	0.00
0.10	0.60
0.20	0.88
0.60	1.00
1.60	1.00
2.00	0.40
3.50	0.04
4.30	0.00
100.00	0.00



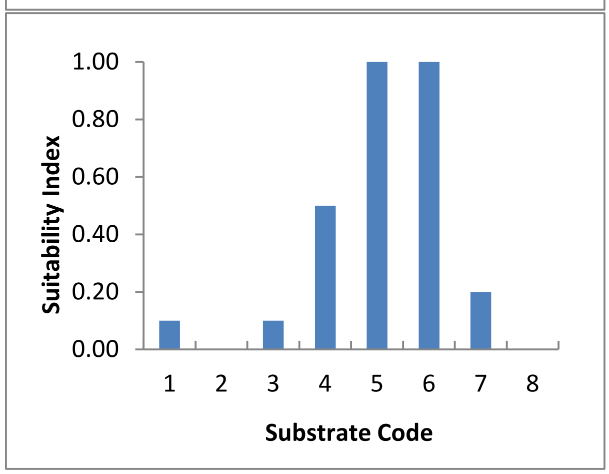
Depth

Depth	SI Value
0.00	0.00
0.40	0.00
0.60	0.11
1.00	1.00
3.00	1.00
4.00	0.27
7.00	0.24
8.00	0.07
100.00	0.07



Substrate

Substrate	SI Value	Type
1	0.10	Detritus/Organic
2	0.00	Mud/soft clay
3	0.10	Silt
4	0.50	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	0.20	Boulder
8	0.00	Bedrock

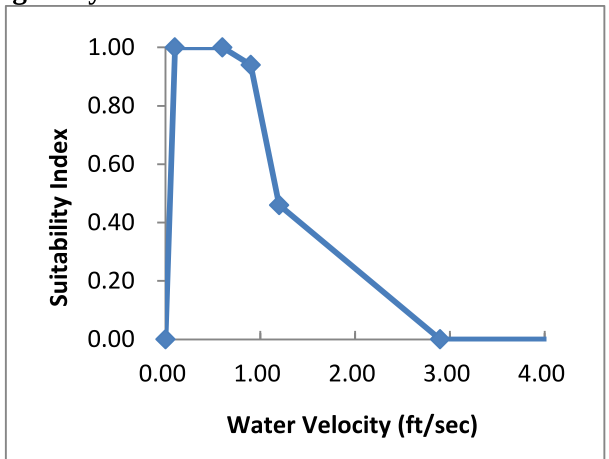


Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Fallfish
Lifestage: Fry

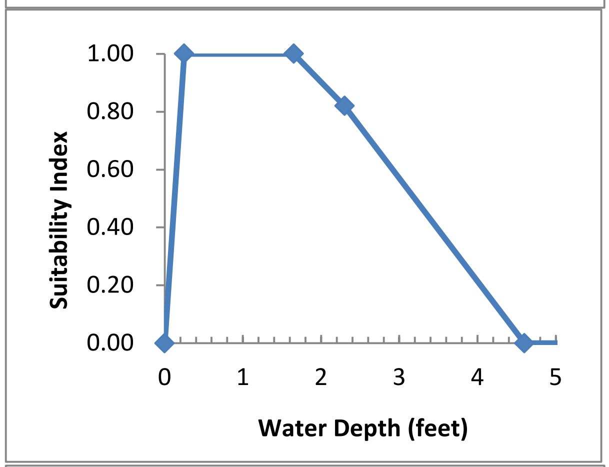
Velocity

Velocity	SI Value
0.00	0.00
0.10	1.00
0.60	1.00
0.90	0.94
1.20	0.46
2.90	0.00
100.00	0.00



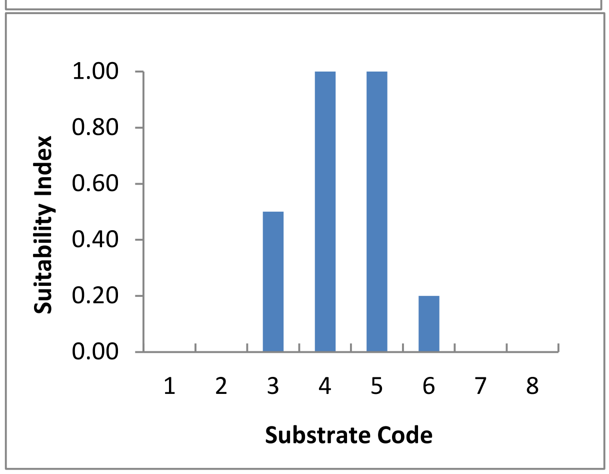
Depth

Depth	SI Value
0.00	0.00
0.25	1.00
1.65	1.00
2.30	0.82
4.60	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.50	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.20	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock



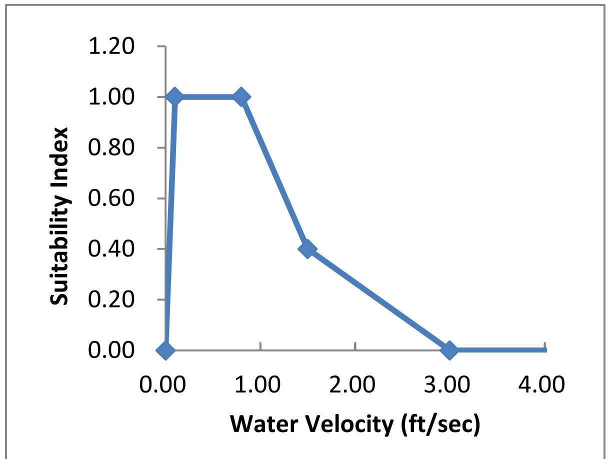
Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Fallfish

Lifestage: Adult

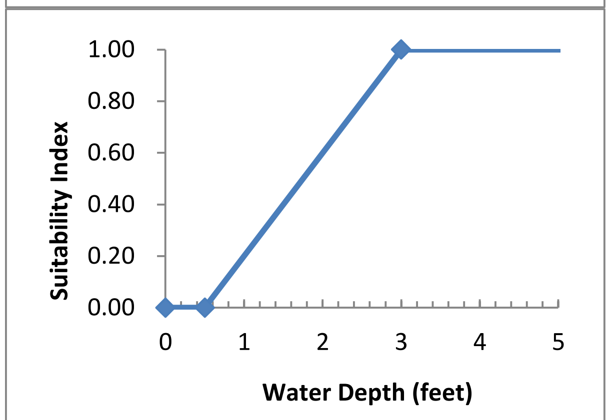
Velocity

Velocity	SI Value
0.00	0.00
0.10	1.00
0.80	1.00
1.50	0.40
3.00	0.00
100.00	0.00



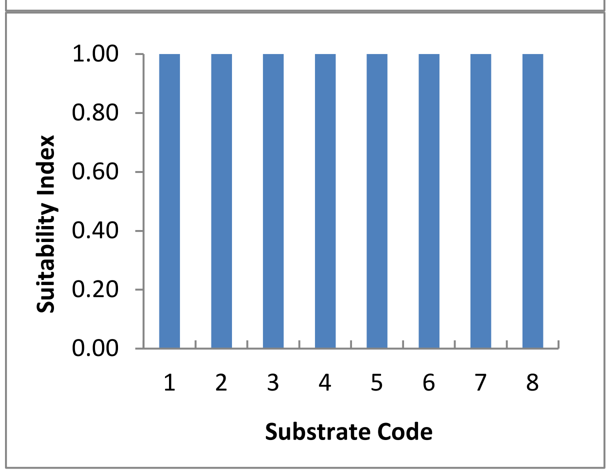
Depth

Depth	SI Value
0.00	0.00
0.50	0.00
3.00	1.00
100.00	1.00



Substrate

Substrate	SI Value	Type
1	1.00	Detritus/Organic
2	1.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	1.00	Boulder
8	1.00	Bedrock



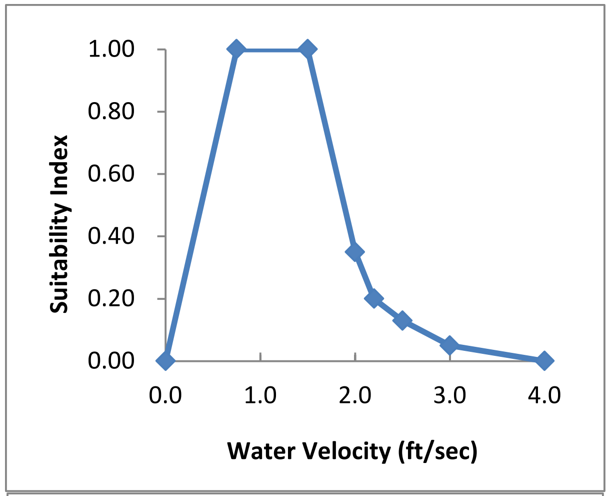
Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Longnose dace

Lifestage: Juvenile

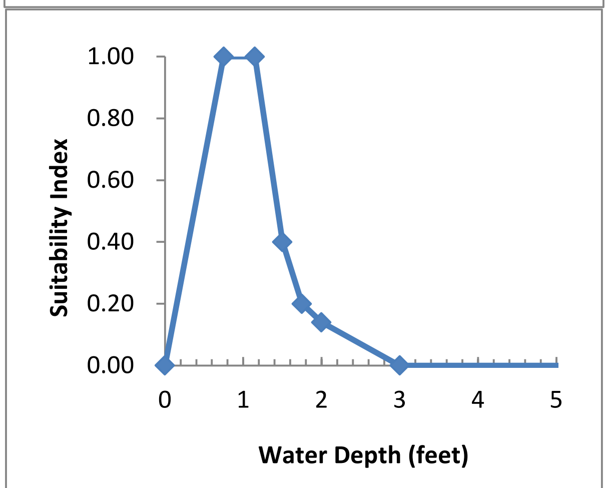
Velocity

Velocity	SI Value
0.00	0.00
0.75	1.00
1.50	1.00
2.00	0.35
2.20	0.20
2.50	0.13
3.00	0.05
4.00	0.00
100.00	0.00



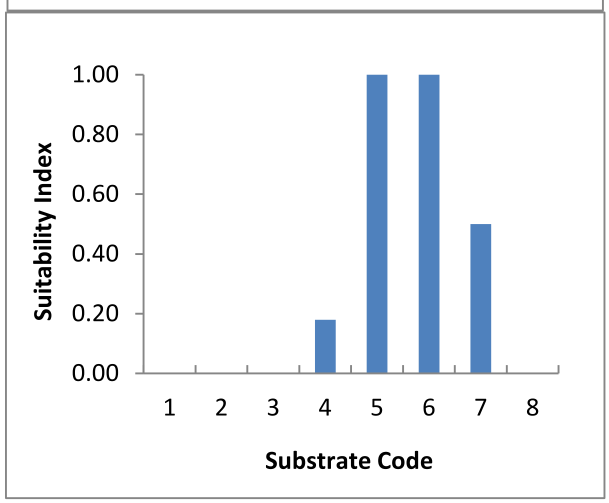
Depth

Depth	SI Value
0.00	0.00
0.75	1.00
1.15	1.00
1.50	0.40
1.75	0.20
2.00	0.14
3.00	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.18	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	0.50	Boulder
8	0.00	Bedrock



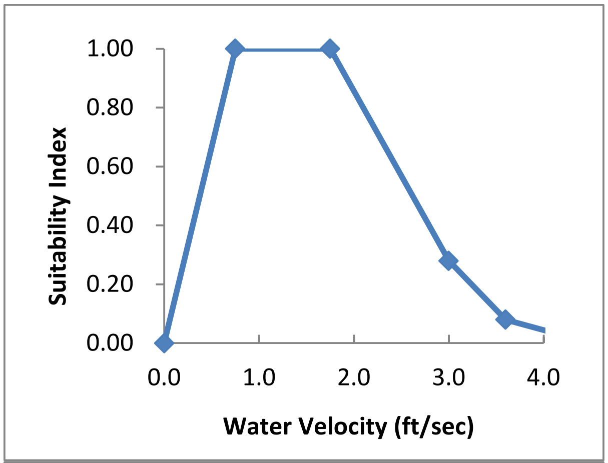
Source: Lamoille River IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Longnose dace

Lifestage: Adult

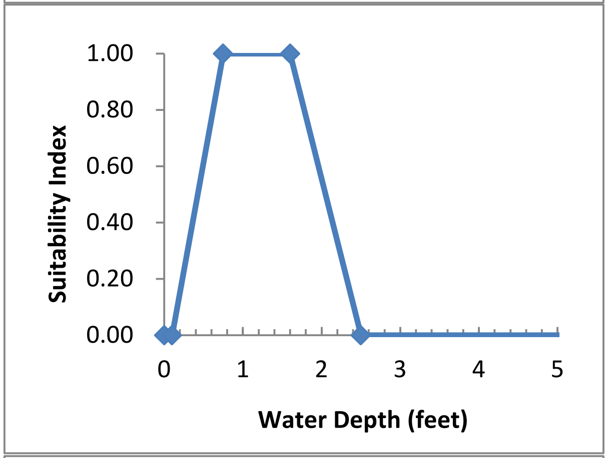
Velocity

Velocity	SI Value
0.00	0.00
0.75	1.00
1.75	1.00
3.00	0.28
3.60	0.08
4.50	0.00
100.00	0.00



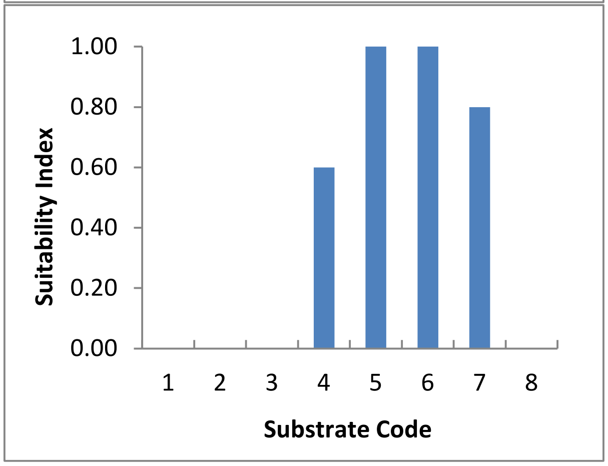
Depth

Depth	SI Value
0.00	0.00
0.10	0.00
0.75	1.00
1.60	1.00
2.50	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.60	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	0.80	Boulder
8	0.00	Bedrock



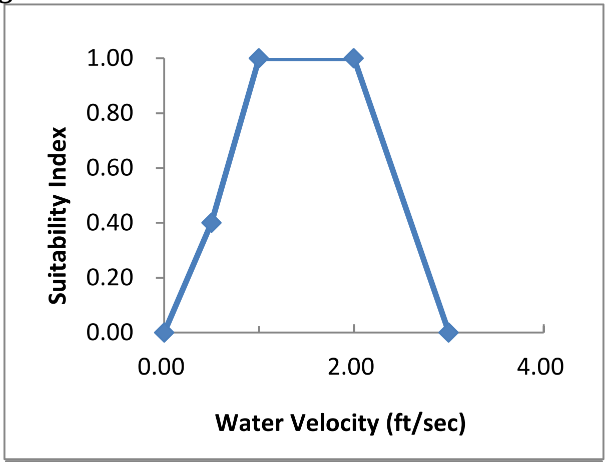
Source: Lamoille River IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: White Sucker

Lifestage: Spawning and Incubation

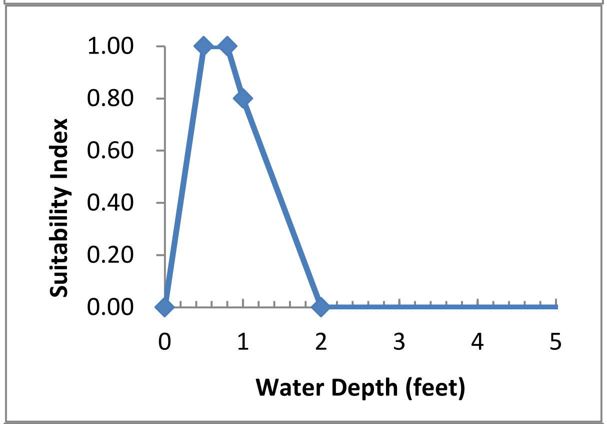
Velocity

Velocity	SI Value
0.00	0.00
0.50	0.40
1.00	1.00
2.00	1.00
3.00	0.00
100.00	0.00



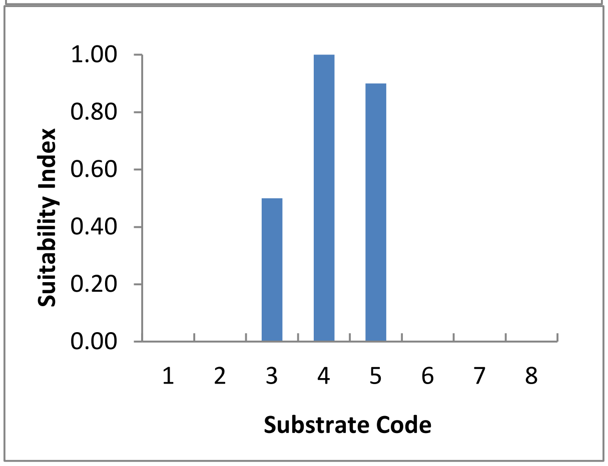
Depth

Depth	SI Value
0.00	0.00
0.50	1.00
0.80	1.00
1.00	0.80
2.00	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.50	Silt
4	1.00	Sand
5	0.90	Gravel
6	0.00	Cobble
7	0.00	Boulder
8	0.00	Bedrock



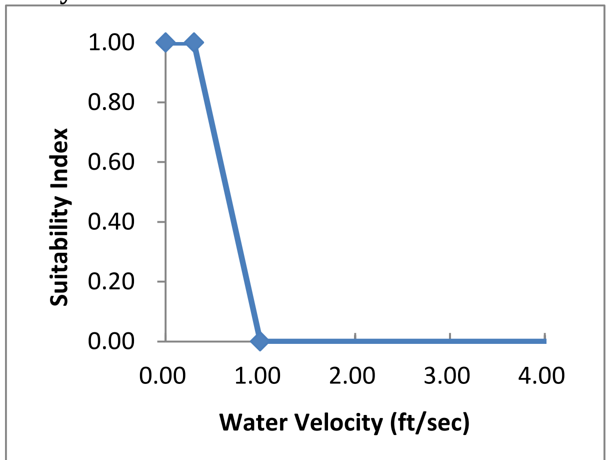
Source: Glendale Hydro IFIM

Species: White Sucker

Lifestage: Fry

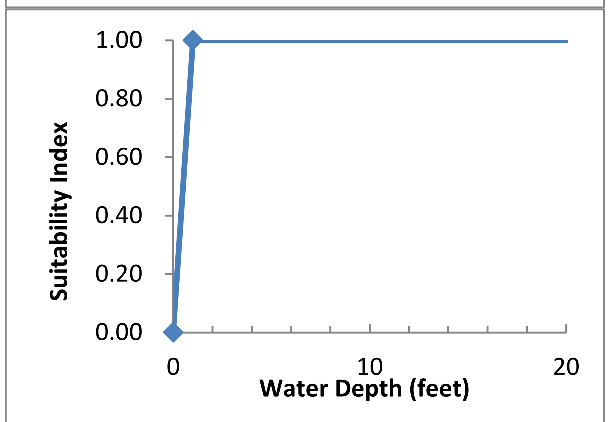
Velocity

Velocity	SI Value
0.00	1.00
0.30	1.00
1.00	0.00
100.00	0.00



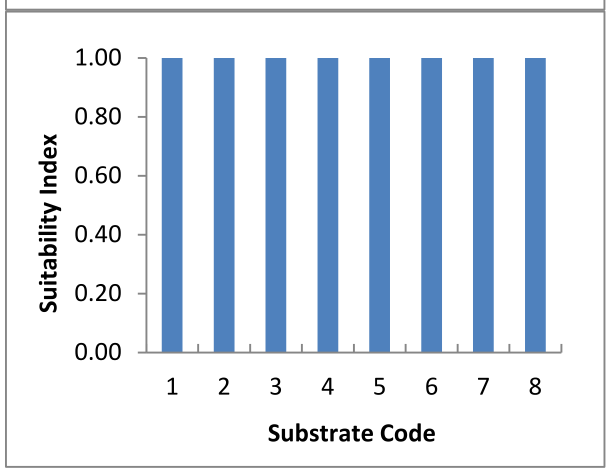
Depth

Depth	SI Value
0.00	0.00
1.00	1.00
100.00	1.00



Substrate

Substrate	SI Value	Type
1	1.00	Detritus/Organic
2	1.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	1.00	Boulder
8	1.00	Bedrock



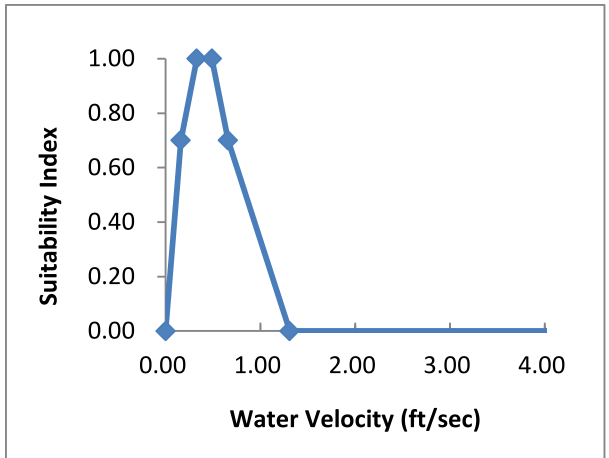
Source: Twomey et al., 1984

Species: White Sucker

Lifestage: Adult/Juvenile

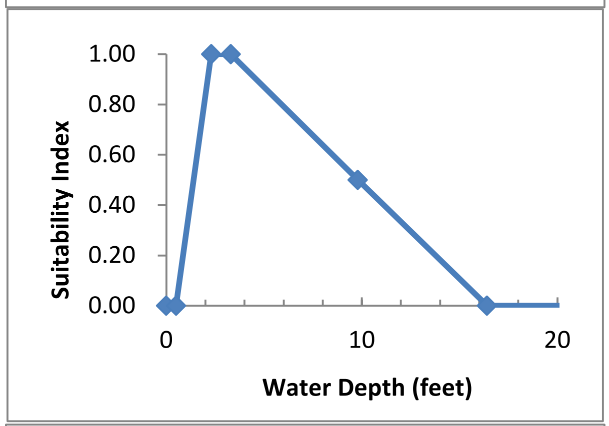
Velocity

Velocity	SI Value
0.00	0.00
0.16	0.70
0.33	1.00
0.49	1.00
0.66	0.70
1.31	0.00
100.00	0.00



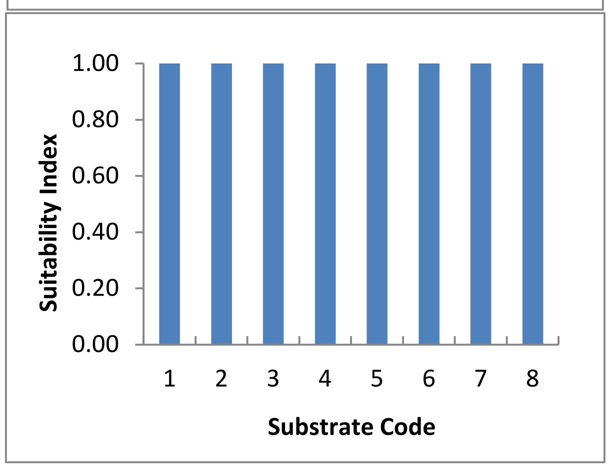
Depth

Depth	SI Value
0.00	0.00
0.50	0.00
2.30	1.00
3.30	1.00
9.80	0.50
16.40	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	1.00	Detritus/Organic
2	1.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	1.00	Boulder
8	1.00	Bedrock



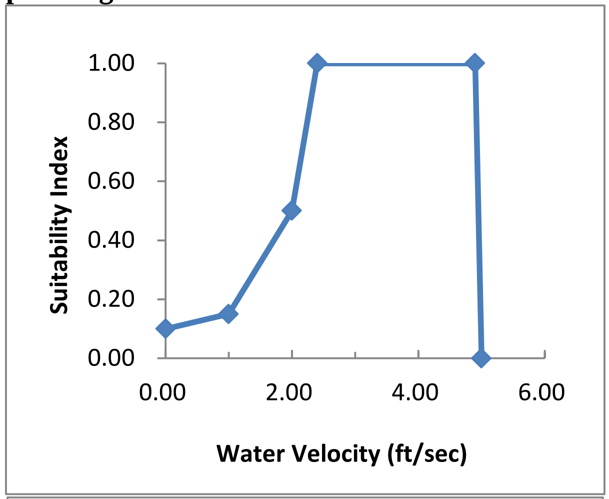
Source: Twomey et al., 1984

Species: Walleye

Lifestage: Spawning

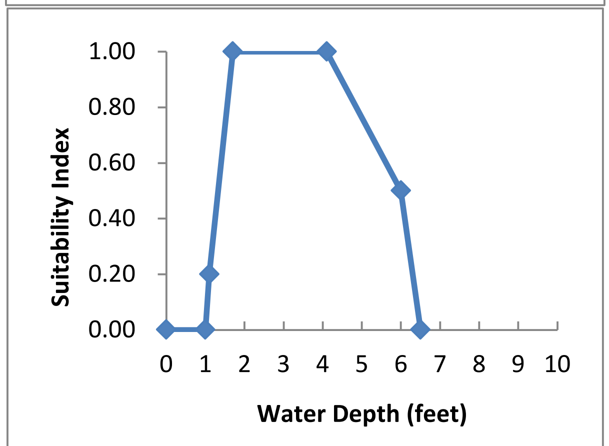
Velocity

Velocity	SI Value
0.00	0.10
1.00	0.15
2.00	0.50
2.40	1.00
4.90	1.00
5.00	0.00



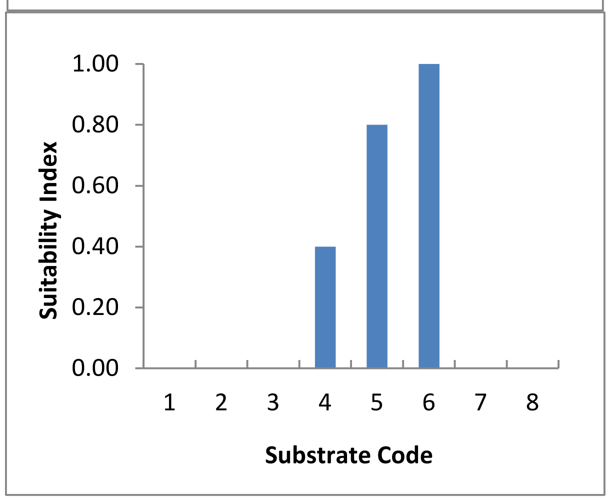
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
1.10	0.20
1.70	1.00
4.10	1.00
6.00	0.50
6.50	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.40	Sand
5	0.80	Gravel
6	1.00	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock



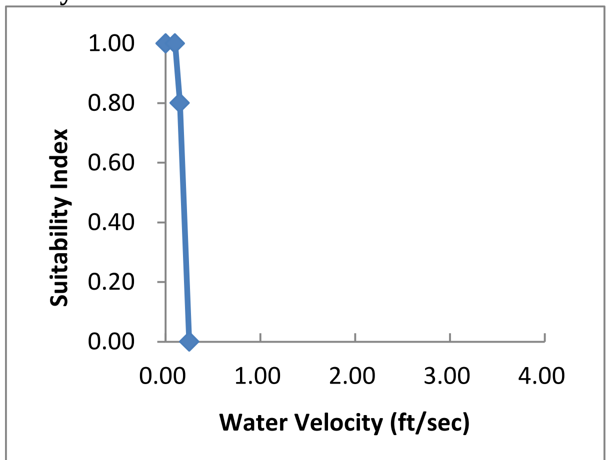
Source: McMahon, et al., 1984. Modified to include velocity and depth data from Bozek, et al., 2011.

Species: Walleye

Lifestage: Fry

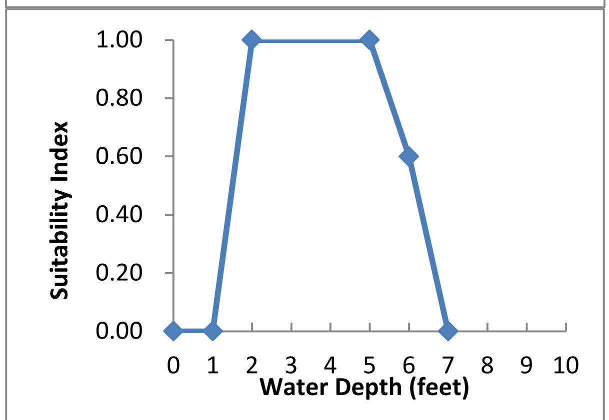
Velocity

Velocity	SI Value
0.00	1.00
0.10	1.00
0.15	0.80
0.25	0.00
2.00	0.00



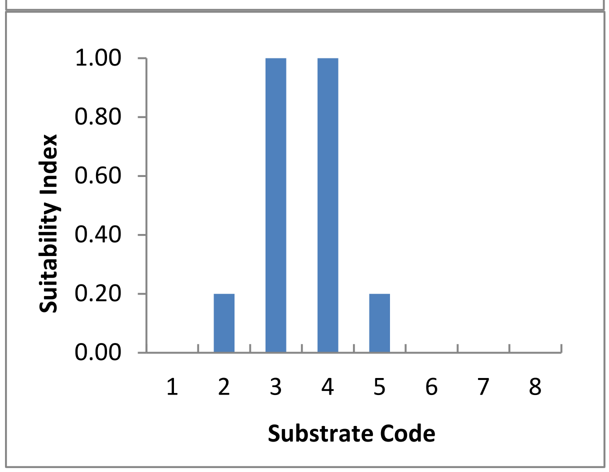
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
2.00	1.00
5.00	1.00
6.00	0.60
7.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	0.20	Gravel
6	0.00	Cobble
7	0.00	Boulder
8	0.00	Bedrock



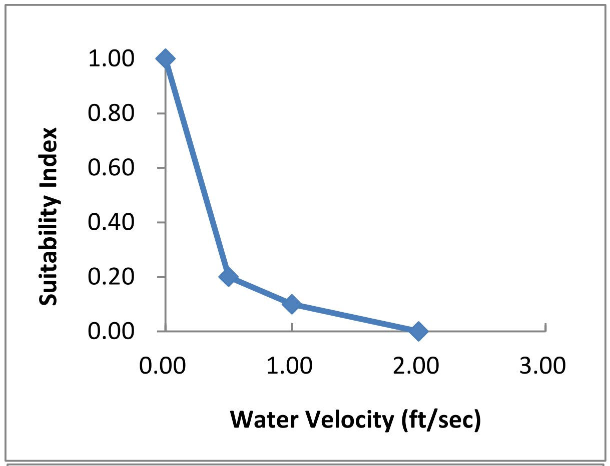
Source: McMahon, et al., 1984.

Species: Walleye

Lifestage: Juvenile

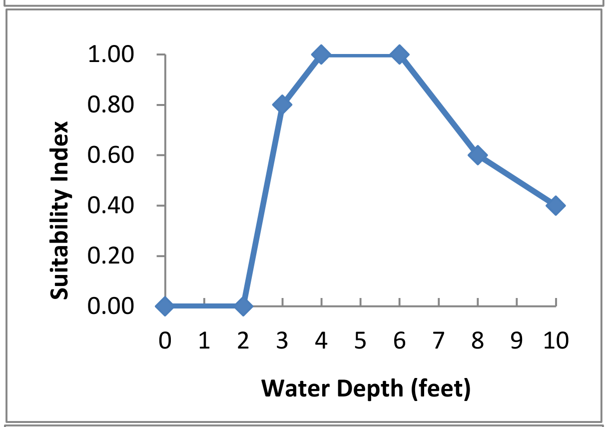
Velocity

Velocity	SI Value
0.00	1.00
0.50	0.20
1.00	0.10
2.00	0.00



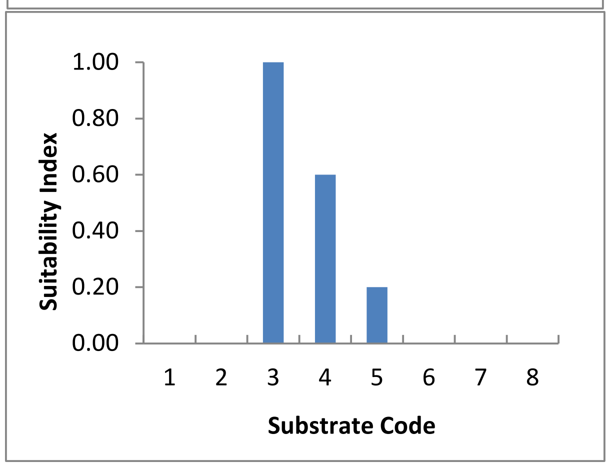
Depth

Depth	SI Value
0.00	0.00
2.00	0.00
3.00	0.80
4.00	1.00
6.00	1.00
8.00	0.60
10.00	0.40
50.00	0.40



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	1.00	Silt
4	0.60	Sand
5	0.20	Gravel
6	0.00	Cobble
7	0.00	Boulder
8	0.00	Bedrock



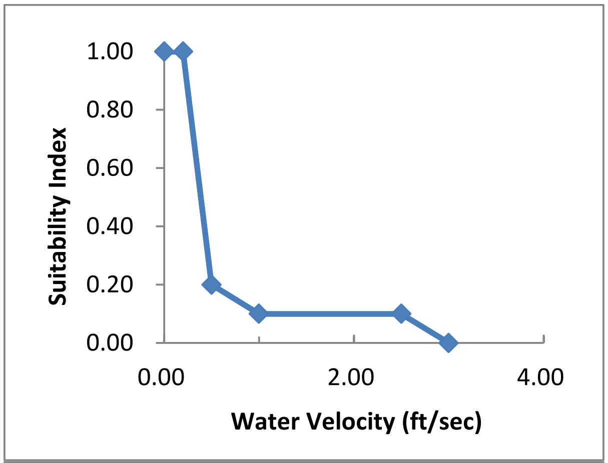
Source: McMahon, et al., 1984.

Species: Walleye

Lifestage: Adult

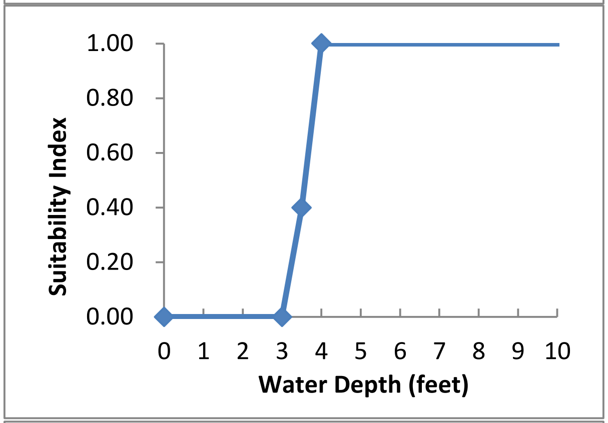
Velocity

Velocity	SI Value
0.00	1.00
0.20	1.00
0.50	0.20
1.00	0.10
2.50	0.10
3.00	0.00



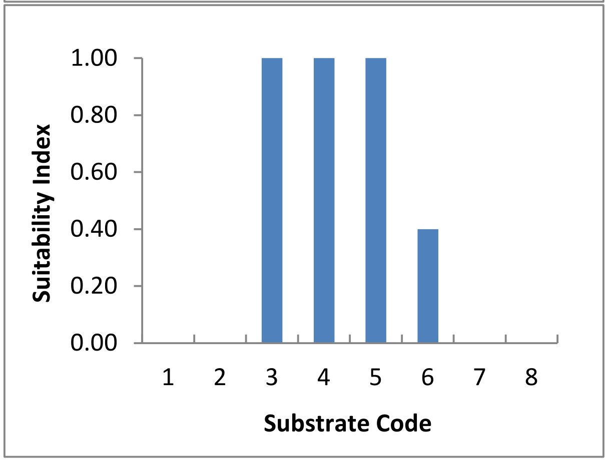
Depth

Depth	SI Value
0.00	0.00
3.00	0.00
3.50	0.40
4.00	1.00
50.00	1.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.40	Cobble
7	0.00	Boulder
8	0.00	Bedrock



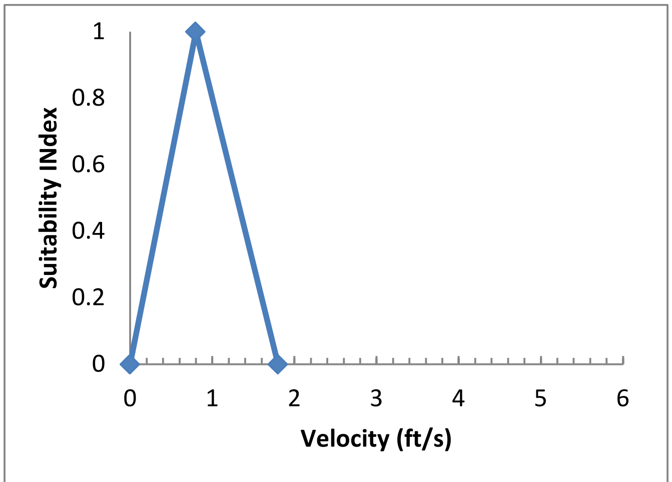
Source: McMahon, et al., 1984.

Species: Tessellated Darter

Lifestage: Adult and Juvenile

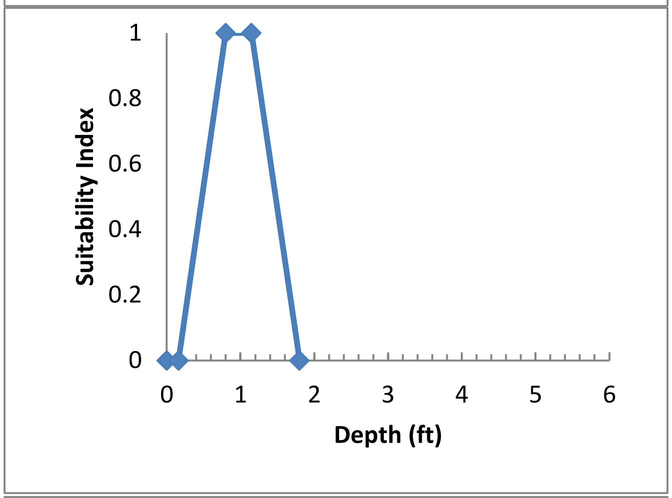
Velocity

Velocity	SI Value
0	0
0.8	1
1.8	0



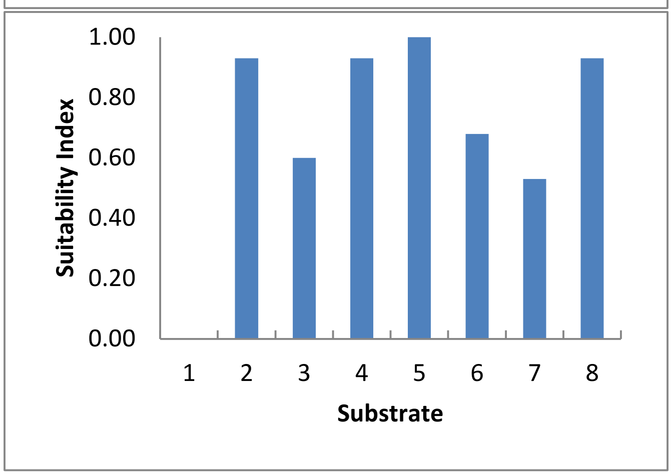
Water Depth

Depth	SI Value
0	0
0.16	0
0.8	1
1.15	1
1.8	0



Substrate

Code	SI Value	Type
1	0.00	Detritus/Organic
2	0.93	Mud/soft clay
3	0.60	Silt
4	0.93	Sand
5	1.00	Gravel
6	0.68	Cobble
7	0.53	Boulder
8	0.93	Bedrock



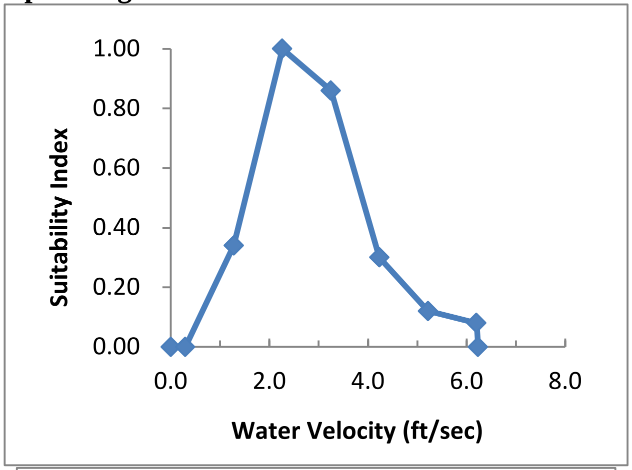
Source: Bell Bend IFIM Study

Species: Sea lamprey

Lifestage: Spawning

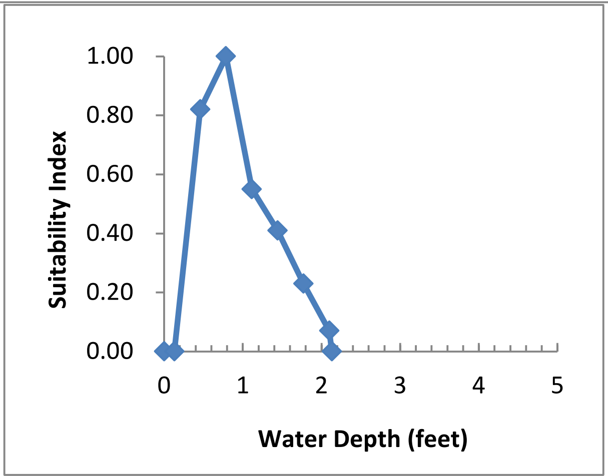
Velocity

Velocity	SI Value
0.00	0.00
0.30	0.00
1.28	0.34
2.26	1.00
3.25	0.86
4.23	0.30
5.22	0.12
6.20	0.08
6.23	0.00



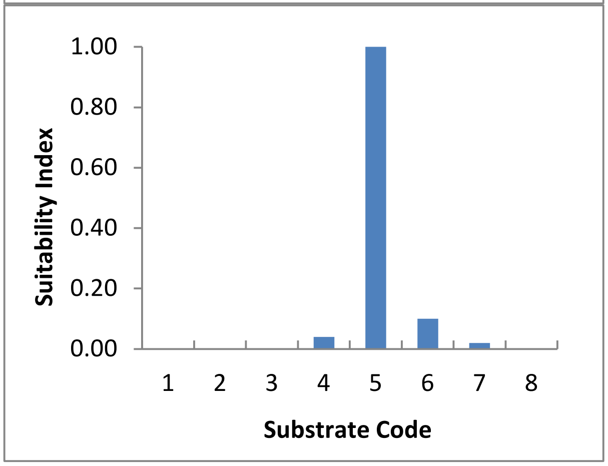
Depth

Depth	SI Value
0.00	0.00
0.13	0.00
0.46	0.82
0.79	1.00
1.12	0.55
1.44	0.41
1.77	0.23
2.10	0.07
2.13	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.04	Sand
5	1.00	Gravel
6	0.10	Cobble/rubble
7	0.02	Boulder
8	0.00	Bedrock

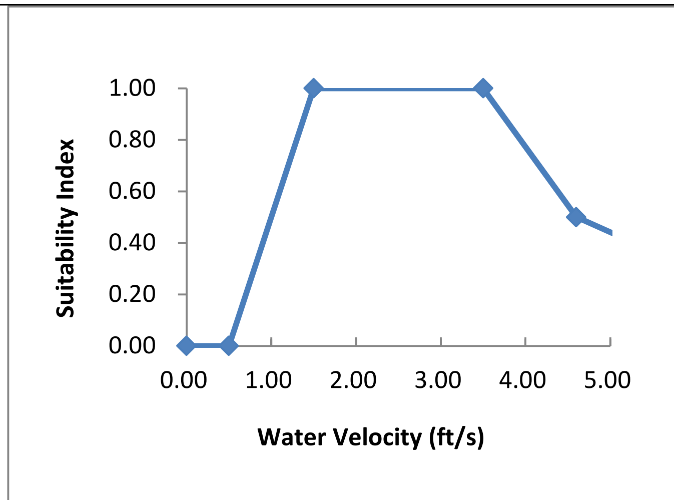


Source: Habitat Suitability Index for Sea Lamprey redds
Boyd Kynard and Martin Horgan 2013
BK-Riverfish, LLC
Consolidated Substrate Codes, converted from metric

Species: Macroinvertebrates

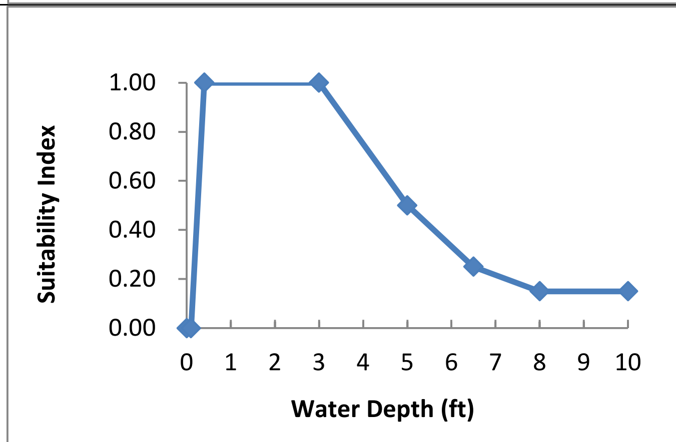
Velocity

Velocity	SI Value
0.00	0.00
0.50	0.00
1.50	1.00
3.50	1.00
4.60	0.50
8.00	0.00



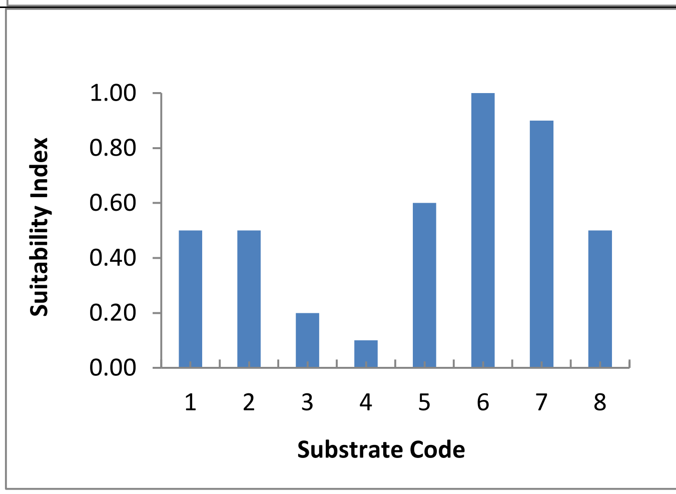
Depth

Depth	SI Value
0.00	0.00
0.10	0.00
0.40	1.00
3.00	1.00
5.00	0.50
6.50	0.25
8.00	0.15
10.00	0.15
100.00	0.00



Substrate

Code	SI Value	Type
1	0.50	Detritus/Organic
2	0.50	Mud/soft clay
3	0.20	Silt
4	0.10	Sand
5	0.60	Gravel
6	1.00	Cobble/rubble
7	0.90	Boulder
8	0.50	Bedrock



Source: Lamoille River IFIM

3.3.2 Evaluate Upstream and Downstream Passage of Adult American Shad

General Description of Proposed Study

An evaluation of upstream and downstream passage of adult American shad has been requested by FERC, USFWS, NOAA, MDFW, NHDES, NHFG, VTDEC, CRWC, TU and the Town of Gill. A telemetry study with both radio and Passive Integrated Transponder (PIT) tag types will be conducted to assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the Turners Falls Project and Northfield Mountain Project during both upstream and downstream migration. Additionally, video recording techniques will be used to evaluate passage efficiency at the Spillway fishway. FirstLight has spent considerable effort in the past studying adult shad passage at the Cabot and Gatehouse ladders (*see* Appendix E). As an initial phase of this study, FirstLight proposes to evaluate this information relative to the objectives of this study to determine if additional field data collection and analysis in these two specific locations is warranted.

A potential alternative to the current configuration of fishways at the project would be to minimize attraction to the Cabot ladder and operate a single fish lift facility at the dam. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. The effect of different levels of dam releases that would induce fish to move past the Cabot Station into the bypass reach and up to the dam will be evaluated. In addition, it is possible that spillway flow releases coupled with a high frequency ultrasound array at the Cabot Station may reduce shad attraction to the tailrace and guide shad into the bypass reach. Study No. 3.3.19 *Evaluate the use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace* proposes to evaluate the use of an ultrasound array to guide fish past the Cabot Station tailrace.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to identify the effects of the Turners Falls and Northfield Mountain Projects on adult shad migration. The study objectives are to:

- ~~Develop a detailed study plan after previously collected data are analyzed;~~Describe the effectiveness of the Cabot fish ladder;
- Describe the effectiveness of the gatehouse entrances;
- Identify migration delays resulting from continued operation of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels;
- [35]Evaluate attraction, entrance efficiency and internal efficiency of the spillway ladder for shad reaching the dam spillway, under a range of spill conditions;
- Evaluate migration through the Turners Falls Impoundment;
- Identify impacts of Northfield Mountain operations on upstream and downstream adult shad migration, including delays, entrainment, behavioral changes and migration direction shifts.

[35] This may be achieved with existing information; FirstLight is awaiting data from the USGS Conte Laboratory.

- Determine downstream passage route selection, timing/delay, and survival at Turners Falls Dam; and

- Determine passage rates and routes taken by shad migrating downstream through the canal, and evaluate Cabot Station fish bypass effectiveness.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

In 1992, the Connecticut River Atlantic Salmon Commission (CRASC) developed a draft document titled: *A Management Plan for American Shad in the Connecticut River Basin*.

Management objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

- Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

- Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, aims to maximize the number of juvenile recruits emigrating from freshwater stock complexes via the following objectives::

- American shad must be able to locate and enter the passage facility with little effort and without stress.

- Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.

- Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

- To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

Based on the CRASC plan, USFWS seeks the accomplishment of several resource goals and objectives through the relicensing process for the Turners Falls Project and Northfield Mountain Project. Specific to American shad movement and migration, the agency's goal is to minimize current and potential negative project operation effects, such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Shad Migration through Turners Falls Impoundment

Adult shad movements within the Turners Falls Impoundment were monitored during 1973-1975, primarily in the vicinity of the Northfield Mountain facility and the Vernon Dam tailrace (Layzer, 1975; 1977); these studies identified patterns of movement throughout the impoundment and determined that fish were often located in deeper areas. The location with the most shad detections was a deep area below the Northfield Mountain tailrace (Layzer, 1977). A deep, turbulent area known as the Narrows near French King Rock was identified as a location where delay occurred (Layzer, 1975).

Passage through the Turners Falls Complex

Many previous studies have been conducted on shad migration and/or passage within the Turners Falls Complex; for a list of publications and reports, see Appendix E. Adult shad movements have also been studied in the Turners Falls power canal starting in the mid-1980's (BioSonics, 1985; ERC, 1987); the approach to the Gatehouse fishway was identified as an obstacle to shad passage.

More recently, researchers at the Conte Lab have expended considerable effort monitoring passage at Turners Falls Project, with PIT, telemetry, or a combination of those methods having been employed from 1999 through 2012. PIT tagging studies, sometimes in combination with telemetry, were conducted during 2000-2003. These studies primarily evaluated shad passage performance through the Turners Fall complex. Areas of evaluation included Cabot fishway, Spillway fishway, Gatehouse gallery and fishway, the power canal, and the river from Holyoke to Turners Falls (Sullivan et al., 2002; CAFRC, 2003).

Further PIT tag assessment of the Cabot fishway (Sullivan, 2004) determined that 57% of shad that enter the fishway did not ascend past the lower third of the fishway, and problems were identified within the ladder (Haro & Castro-Santos, 2005). In general, the numbers of fish passing through the Spillway fishway were too low for rigorous evaluation (Haro & Castro-Santos, 2005).

Some of the more recent studies have evaluated adult shad passage into the Gatehouse fishway following modifications intended to improve passage, using PIT and radio telemetry (Haro & Castro-Santos, 2009; Haro & Castro-Santos, 2010). Passage through the Gatehouse improved after modifications, but the studies were unable to discern the ultimate cause of improved passage because multiple modifications were made. This study also found that fish which were transported from Holyoke exhibited improved passage relative to those which ascended the Cabot fishway, possibly indicating that stress and delay through the Cabot fishway could result in reduced passage at the Gatehouse.

Whole-River Telemetry Studies

In addition, shad telemetry studies from the mouth of the Connecticut River to Vernon Dam and beyond were performed in 2011 and 2012. These data should help assess delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies. The studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam. Similar patterns were noted in 2012 (T. Castro-Santos, personal communication). Similarly, concerns relative to delay of downstream passage of spent shad remain. relative to delays, with existing unpublished USGS telemetry data sets suggesting this is may be issue within the Turners Falls power canal.

The Need for Additional Information

Due to the relatively large amount of data gathered by previous studies, it is possible that some objectives of this study may already be partially satisfied, or that this study could be designed to address questions raised by results of those studies; however, the data require further analysis prior to reaching conclusions regarding their relevance to this study.

Project Nexus (18 CFR § 5.11(d)(4))

Project operations may affect passage route selection, entry into fishways, and create delays to upstream and downstream migration. The project's upstream and downstream passage facilities should be designed and operated to provide effective upstream and downstream fish passage.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The proposed study will build and expand on the information collected by the Conte Lab and FirstLight. Previous data will be used to identify potential locations where further or more detailed information is required to evaluate shad migration through the Turners Falls and Northfield Mountain Projects; after a detailed study design is developed, shad migration will be monitored using telemetry and video monitoring techniques. If the 2014 results indicate that shad will migrate to the spillway ladder but are attracted to the Cabot discharge, Study No. 3.3.19 *Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace* will be conducted to determine if use of ultrasound technology would be an effective method to minimize attraction to the tailrace discharge while facilitating movement past the Cabot discharge and up to the spillway area. If tag frequencies are provided by shad tagged by TransCanada, these fish will also be available for assessing entrainment and passage via spillage. Due to the iterative process of collating and reviewing existing information to inform FirstLight and stakeholders in determining specific details for field studies, the Study Schedule section below identifies an estimated timeline for data review and consultation with the stakeholders.

Task 1: Review Existing Information

Analysis of previously collected data will be completed in 2013 to help inform the design of subsequent field studies and to determine whether some objectives (i.e. the description of the effectiveness of the Cabot Ladder and gatehouse entrance) have already been met with recent existing data. Substantial data have already been collected at Turners Falls Project from multiple years of passage assessments conducted for FirstLight by Conte Lab researchers, which will be useful to determine whether further study of those areas is required or if this study should focus efforts elsewhere. Data were also collected for the 2011 and 2012 full river study conducted by the Conte Lab that address migration and passage questions at the Turners Falls and Northfield Mountain Projects that have not yet been analyzed. Fish count and operational data will also be analyzed as part of this study, with the existing information compiled in a summary report to inform the development of the subsequent study tasks.

Task 2: Develop Study Design

Once the analysis of existing data is completed in 2013 a detailed study design will be developed in consultation with the resource agencies and will specify sample sizes, and confirm receiver configurations. Existing information will be analyzed to determine how many shad tagged at Holyoke migrated to Cabot Station during prior studies. Because this is an upstream and downstream assessment, other parameters will be evaluated in order to determine sample size, such as expected passage efficiency and fallback rates, and a determination if supplemental release locations are warranted in development of the study design. In addition, tagged fish performance, along with other factors such as timing of tagging and transport, will be considered to ensure an adequate sample size of healthy tagged fish is available to address study objectives.

Stationary monitoring stations (radio and PIT) will be designed to address the issues identified among the project areas, and will provide an appropriate level of resolution to fulfill the objectives of the study. A preliminary list and map of proposed stationary receiver locations have been developed and may be further refined based on results of Task 1 (Table 3.3.2-1 and Figure 3.3.2-1 through Figure 3.3.2-4). Further refinement may occur in the field if additional antennas and /or receivers are needed to provide bank to bank coverage. Range testing will be conducted prior to study set-up. Additionally, manual tracking via boat or vehicle throughout the study area will be conducted at least twice per week.

A plan and schedule for dam flow releases will be developed. Flows between 2,500 and 6,300 cfs will be evaluated as they have been identified as the range of flows needed for successful spawning for ESA-listed shortnose sturgeon which occurs at the same time as upstream shad passage. Flow ranges may be further refined based on results of the instream flow study in the bypass reach (Study No. 3.3.1).

Task 3: Evaluation of Route Selection and Delay

Radio Telemetry Tracking

Fish will be captured at Holyoke Dam, tagged with radio and PIT tags, and released upstream of Holyoke Dam. Tagged fish will be tracked throughout the study area during both upstream and downstream migration with fixed antennae and mobile tracking; the use of PIT tags in addition to radio telemetry tags will provide an inexpensive safeguard in the event of radio tag loss, and would also allow for precise tracking within fishways. Use of radio, including PIT telemetry is a widely accepted method to assess fish migratory behavior and passage success and has been used to assess migration and passage issues at the Turners Falls Project, as well as other Connecticut River projects. However, these methods have also been shown to alter the behavior (i.e. fallback) and survival of tagged fish; consideration of these effects will be important in the interpretation of the study results.

Additional tagged individuals may need to be released farther upstream (Turners Falls power canal, upstream of Turners Falls Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes in order to address the objectives.

Video Monitoring

Video monitoring will be used for specific study areas such as the Spillway fishway. Use of video monitoring of the Spillway fishway will provide data on fishway efficiency; all shad attempting to pass would be monitored versus only those shad that have been tagged. FirstLight proposes to conduct video monitoring using the Delta Vision commercial series of underwater video camera and lighting manufactured by Ocean Systems Inc. This system was recommended by A. Haro (Conte Lab) and proven effective at other facilities. Video data will be recorded on a dedicated digital video recorder.

Task 4: Evaluation of Mortality

The telemetry study will use motion sensor telemetry tags that will give researchers an indication of passage induced mortality. Mortality will be assessed at locations where tagged fish as part of the radio tracking study in Task 3 are subjected to entrainment or passage via spillage.

Task 5: Reporting

An initial report summarizing existing data evaluated in Task 1 will be prepared. Following the completion of Tasks 2-4, a report will be prepared including a summary of the results of the collected telemetry data along with analyses of American shad migration and behavior throughout the study area in the Connecticut River. Collected biological information, water quality data, river conditions, project operations and flow conditions, and the condition of project facilities during the time of the study will be included in the report. Flow and project operational parameters shown in Table 3.3.2-2 will be utilized in the data analyses. Tagged-shad movements during the study will be graphically displayed. All data used to develop the report will be included in an appendix.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The analysis of existing data and data from the requested study will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $415,000 to $520,000 based on past Turners Falls Project studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The following process is proposed in order to develop a detailed study plan utilizing existing information to inform decision making.

- FirstLight will provide a summary of information we expect to learn from review of the existing data and summarize existing shad telemetry reports – September 2013
- FirstLight to obtain, compile and analyze existing data from Conte Lab studies and utilize results to develop a detailed study plan, including specifics such as specific sample sizes, receiver configurations and camera locations and provide detailed study plan to Stakeholders for review and comment, including meetings if determined appropriate –November 2013
- Finalize detailed study plan for filing with FERC –December 2013

Adult American shad migrate into the lower Connecticut River during late March or early April. Fish lift operation at the Holyoke Project, located downstream, typically begins on April 15, with shad reaching Cabot Station in late April or early to mid- May. As such, the telemetry based monitoring system will be deployed, calibrated and tested in late March and early April 2014, prior to the arrival of adult shad to the study area. Test fish will be collected at the Holyoke Project and released at various locations upstream. Prior work conducted in the Connecticut River has shown that early migrating shad have the strongest migratory drive, traveling the farthest upstream (T. Castro-Santos, USGS Conte Lab, personal communication). These early migrants will be targeted for use in the study to maximize the potential for test fish to reach and interact with the Turners Falls and Northfield Projects. American shad migrate up river when water temperatures are generally between 12 and 20°C; spawning occurs from 14 to 23°C when river flow is generally declining from the spring peak. Spent outmigrants travel downstream shortly after spawning. The exact timing of the out-migration will be dependent on many factors, most notably water temperature. The study field work is anticipated to conclude by early July 2014. Depending on the results of the 2014 study results, a second year of field work may be conducted.

Literature Cited

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Sullivan, T., Haro, A., & Castro-Santos, T. (2002). Passage of American Shad at Turners Falls Fishways: PIT Tag Evaluation. CAFRC Internal Report No. 2002-01.

Sullivan, T.J. (2004). Evaluation of the Turners Falls Fishway Complex and Potential Improvements for Passing Adult American Shad. M.S. Thesis, University of Massachusetts.

Table 3.3.2-1: Proposed locations and types of monitoring and telemetry equipment proposed for the upstream and downstream passage of adult shad study.

Location	RM	Receiver Station
Red Cliffe Canoe Club (upstream of Holyoke Dam)	86.5	ORION
Sunderland Route 116 Bridge	111	ORION
Montague Wastewater	119.5	ORION
Deerfield River Confluence	119.5	ORION
Cabot Station Tailrace	120	Lotek SRX
Cabot Station Forebay	120	Lotek SRX
Cabot Fish Ladder	120	PIT Tag Reader
Rawson Island	120.5	Lotek SRX
Station 1 Forebay	121	Lotek SRX
Station 1 Tailrace	121	Lotek SRX
Turners Falls Spillway Ladder	122	PIT Tag Reader/Video
Below Turners Falls Dam	122	Lotek SRX
Gatehouse Entrance	122	PIT Tag Reader
Turners Falls Impoundment	122	Lotek SRX
NMPS Gill Bank	126.5	Lotek SRX
NMPS Intake	127	Lotek SRX
Shearer Farm	127.5	Lotek SRX
NMH Boathouse	133	Lotek SRX

Holyoke Dam is located at River Mile 86.0.

Table 3.3.2-2: Proposed flow and Project operational parameters which will be compiled for the adult American shad movement study.

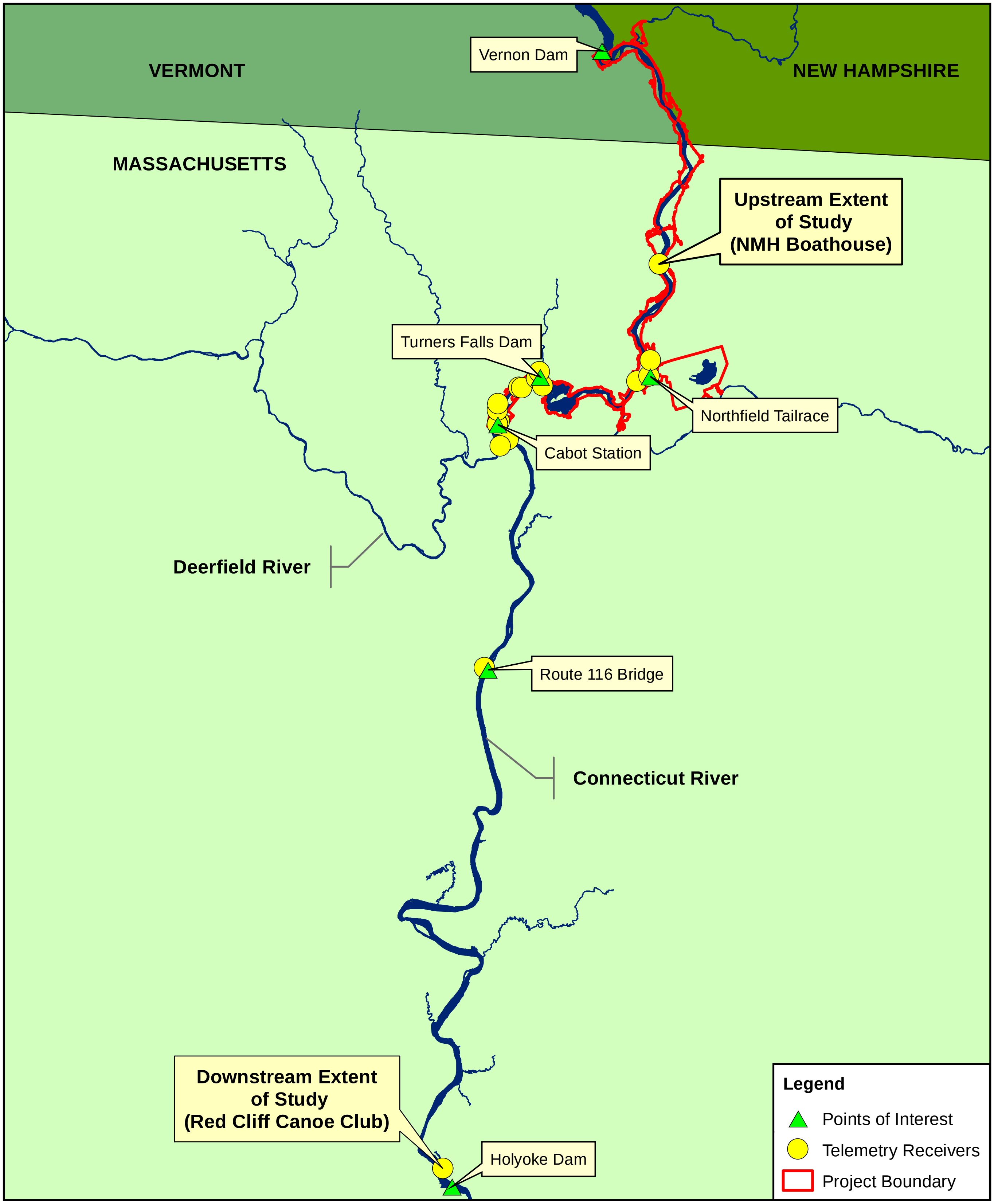
Parameter	Units
Water Surface Elevation	
Vernon Tailwater	Feet, above mean sea level
Northfield Mountain Tailrace	Feet, above mean sea level
Turners Falls Impoundment @ Boat Barrier	Feet, above mean sea level
Turners Falls Dam	Feet, above mean sea level
Discharge	
Vernon Dam	cfs
Ashuelot River	cfs
Millers River	cfs
Connecticut River Natural Routed Flow	cfs
Bypass Reach Flow	cfs
Deerfield River at West Deerfield, MA	cfs
Fishway Discharge	
Cabot Ladder	cfs
Spillway Ladder	cfs
Gatehouse Ladder	cfs
Downstream Fish Passage Sluiceway	cfs
Station Generation	
Northfield Mountain	MW
Station No. 1	MW
Cabot Station	MW

Notes:

Data interval will be on at least a 15-minute time step, pending data availability.

All MW data will be converted to approximate flow through a ratio of design flow (cfs) to design capacity (kW)

Connecticut River Natural Routed Flow is a calculation summing discharges from Vernon Station, Ashuelot River and Millers River



FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

N

0 2 4 8 Miles

Figure 3.3.2-1: Overview of American Shad Radio Telemetry Locations

Path: W:\gis\maps\Shad Tracking Study\Figure 3.3.2-1.mxd

FirstLight Power Resources GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

0 500 1,000 Feet

Figure 3.3.2-2: American Shad Radio Telemetry Locations near Cabot Station

Path: W:\gis\maps\Shad Tracking Study\Figure 3.3.2-2.mxd

FirstLight Power Resources
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

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Figure 3.3.2-3:
American Shad Radio Telemetry Locations nearTurners Falls Dam

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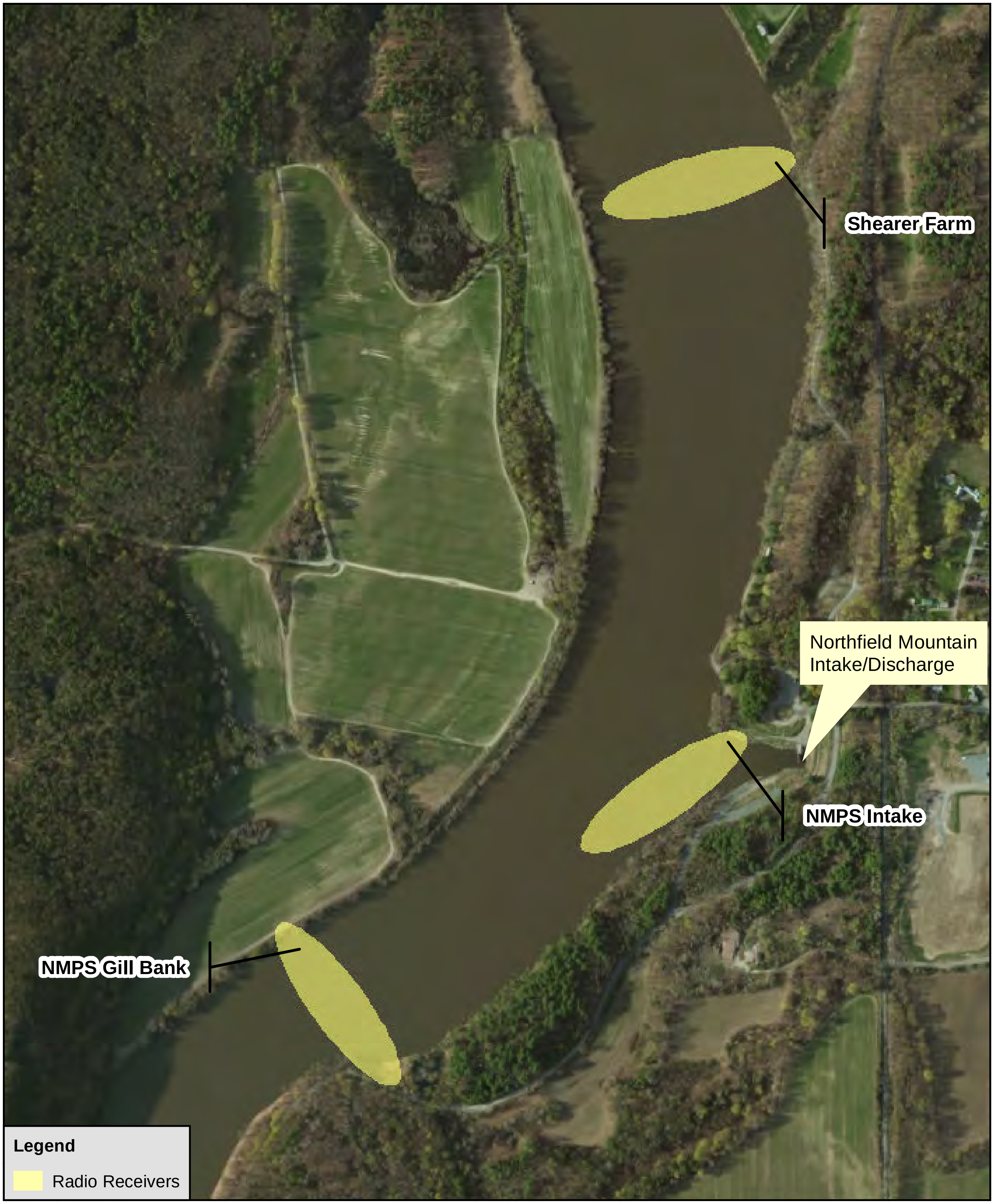

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Proposed Study Plan

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Figure 3.3.2-4:
American Shad Radio Telemetry Locations near Northfield Mt. Intake

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3.3.3 Evaluate Downstream Passage of Juvenile American Shad

General Description of Proposed Study

An evaluation of downstream passage of juvenile American shad has been requested by USFWS, NOAA, MDFW, NHFG, VTDEC, CRWC, TU and the Town of Gill. A field study of juvenile American shad outmigration through the Turners Falls Impoundment and power canal and over Turners Falls Dam, will be conducted to assess outmigration success.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine if project operations affect juvenile American shad outmigration success.

Study objectives are to obtain information to:

- Assess the effects of the Projects on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that pass downstream through the power canal versus over the dam under varied operational conditions, including a range of spill conditions;
- Determine the rate of downstream movement within the impoundment, over the dam and through the bypass reach, or through the power canal;
- Determine survival rates for juveniles spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine downstream passage timing, route selection, and rate of movement of juvenile shad through the power canal to Station No. 1, Cabot Station and the Cabot Station bypass;
- Determine the rate of entrainment at the Northfield Mountain Project;
- Determine the survival rate for juvenile shad entrained into Station No.1; and
- Determine the survival rates for juvenile shad entrained at Cabot Station.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

In 1992, the CRASC developed a draft document titled: *A Management Plan for American Shad in the Connecticut River Basin*.

Management Objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

- Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, aims to maximize the number of juvenile recruits emigrating from freshwater stock complexes.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

American shad have had access to spawning and rearing habitat upstream of Turners Falls Dam since passage was provided via fishways in 1980. Effective downstream passage and successful spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River. American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al., 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco & Savoy, 1984). Rate of movement in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al., 2003). During the peak of the migration, juvenile shad captured by O'Leary and Kynard (1986) averaged 97 – 100 mm in total length.

Juvenile shad abundance has been shown to be negatively correlated with Connecticut River flow in June (Crecco & Savoy, 1984). Juvenile shad are abundant in many river locations throughout the summer, where they provide a forage base for predatory fish. Although some fish may move downstream through the Project from August to November (O'Donnell and Letcher, 2008), the peak seaward migration out of the Connecticut River occurs in September through October.

Much daily movement occurs in evening and night hours until about 2300 h but movement can occur round-the-clock. The young migrate to areas in the North Atlantic and remain at sea for four to six years before returning to their native river to spawn.

Downstream juvenile clupeid passage studies were conducted at Turners Falls in the fall of 1991 and 1992 (Harza & RMC, 1992; 1993) to determine the percentage of juvenile shad and herring that passed downstream via the bypass log sluice and the Cabot Station turbines. An estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice prior to installation of a special weir in the mouth of the bypass in 1992. The weir design was developed to narrow and deepen the entrance to the bypass and reduce the rate of flow acceleration approaching it. Following installation of the weir an estimated 87% of juvenile shad passed through the log sluice in 1992. A follow-up study during fall 1993 determined that 94.4% of juvenile clupeids passed downstream via the log sluice after it was equipped with artificial above-water lighting (RMC, 1994).

Project Nexus (18 CFR § 5.11(d)(4))

Project operations may affect passage route selection, entry into bypass, and rate of downstream migration. The Project's downstream passage facilities need to be designed and operated to provide effective downstream fish passage.

Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require downstream passage to complete their lifecycle and promote recruitment to the basin.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The impact to juvenile shad outmigrants by project operations will be studied using a combination of approaches including hydroacoustic, radio telemetry, and the use of HI-Z Turb'N tags. The study objectives will be met by a tasked approach and the study will be conducted in 2014.

Task 1: Evaluation of Timing, Duration and Magnitude of Migration

The timing, duration, and magnitude of juvenile shad migration at the Turners Falls Project will be evaluated over a range of operational conditions. Hydroacoustics will be deployed in the forebay area at Cabot Station, at the Gatehouse and the Northfield Mountain Project intake. An array of split beam transducers will be deployed to provide sufficient coverage of the targeted areas. The exact location and number of transducers, and orientation will be determined during reconnaissance and test deployment prior to the commencement of the survey to optimize spatial coverage. To the extent possible, transducers will be mounted in areas of limited turbulence and ambient noise and away from eddies or other hydraulics where fish "milling" would occur. Ideally transducers would be mounted as close to the target area as possible. A frequency in the 333 to 430 kHz frequency range will be used to reduce avoidance behavior of shad.

Data will be recorded and archived continuously; however at the Northfield Mountain intake only data recorded during pumpback mode will be analyzed. Depending on the configuration of the system and the target area, fish moving in the direction of the target area, fish size, or other sampled parameters can potentially be used to identify acoustic targets corresponding to shad. Acoustic targets can be filtered by size and supporting data used to apportion the number of fish by size class. The scope and details of such a study cannot be determined at this time but will be designed and executed in consultation with agencies Current plans are to have the hydroacoustic expert on site in mid-August, 2013. It is assumed that numbers of juvenile fish will be estimated based on echo-integration.

Data will be recorded by an on site data logger. Transducers will be inspected and serviced by a qualified technician on a weekly basis, and data will be remotely downloaded and reviewed at least once per week during sampling to qualitatively view trends, and to ensure the system is functioning properly. During analysis, echo data will be analyzed using standard analytical tools such as Echoview ® software, and related to concurrent station operation, water temperature, climatic conditions and Connecticut River flow. Data will be displayed in both tabular and graphic form, and include hourly daily, monthly and full season estimates. To the extent possible data output will also show patterns of spatial distribution of targets in the intake area. The exact number and position of the hydroacoustic transducers will be determined in the field but it is anticipated that a surface transducers with a downward orientation would be deployed. Data from the hydroacoustics will provide information on the timing, frequency and magnitude of the migration, as well as estimates of juvenile shad entering and existing in the Canal and estimates of the numbers entrained at the Northfield Mountain Project. The downstream bypass will be sampled concurrently. Concurrent bypass sampling will be conducted over several discrete events (12 to 18) to ground truth the hydroacoustic data and compare the percent of juvenile shad passing via the Cabot sampler and Cabot Station.

~~Hydroacoustic data will be processed with Myriax Echoview or similar software. The data will be reduced by applying an intensity threshold that is representative of the target size and analyzed with an α,β-tracking algorithm, which identifies the series of echoes that were returned by an individual fish over successive pings. The tracking results will be reviewed on the echogram and exported as a database containing time, target strength, and 3-D positional information for each fish detected. Fish counts will be expanded for the non-sampled area of the intake cross-section. An expansion factor will be calculated for each individual fish as a function of its effective beam width at the range it was observed. This effective~~

~~beam width depends on the acoustic beam pattern and the size of the target. Thus, for a given transducer, at any given range, a large fish can be detected over a wider portion of the intake cross-section than a smaller fish. The expansion factor compensates for this differential detection probability.~~ Task 2: Evaluate Route of Passage Choice, Delay and Spill Survival

Radio telemetry methods will be used to assess routes of downstream passage and occurrences of delay, if feasible. Juvenile shad are fragile and can be difficult to reliably test using methods requiring fish handling and tagging such as telemetry. However, prior telemetry studies conducted with juvenile shad have had success, particularly when large sized (~120mm) hatchery juvenile test fish were used. FirstLight plans to work with the USFWS to hatchery raise juvenile shad to this larger size for use during the tagging studies. The routes of passage will be monitored via a radio telemetry monitoring array such that each route of passage (i.e., over the dam, Station No. 1, Cabot Station, the fish bypass and through the canal) is monitored. Receivers will be set up above and below the Turners Falls Dam to determine spillage survival. Study fish will be raised at the USFWS hatchery (*details to be determined in consultation with USFWS*), radio tagged and released at least 1 mile upstream of the Turners Falls Dam. It is proposed that groups of fish tagged with external radio transmitters (5 mm wide X 3 mm high X 14 mm long with a weight less than 0.5 g, 8 day battery life) will be released. Proposed sample sizes for this study have not been determined yet; FirstLight will determine appropriate sample sizes and provide justification for such prior to study execution in consultation with the fisheries agencies.

Task 3: Turbine Survival

HI-Z Turb'N tags will be used to empirically determine rates of survival for fish entrained at Station No. 1 and Cabot Station. As currently envisioned, a minimum of 150 tagged shad will be released into turbines for testing and an additional 150 will be released into the tailrace as controls. This sample size should result in a survival estimate that is ± 10% 90% of the time (α=0.10). FirstLight is still evaluating samples sizes and will confirm appropriate sample sizes and provide justification for such prior to study execution in its revised study plan.

The tagged fish will be proportionally allocated by the number of different turbine types at Station No. 1 and Cabot Station. All six turbines at Cabot Station are similar type and hydraulic capacity so testing will be conducted at one turbine at Cabot Station as a representative unit. Data for that unit will be extrapolated to calculate a total station survival rate. Station No. 1 has five Francis style turbines. Four of the five turbines are similar in speed, hydraulic capacity (490 to 560 cfs) and have double runners and one is smaller (140 cfs) with a single runner. Testing will be conducted at two turbines at Station No. 1 (at one to represent the four larger units and at the smaller capacity unit). Like Cabot, the data for the representative unit will be extrapolated to calculate a total survival rate for all four units and combined with the data for the smaller unit for a total station survival rate. Tests will be conducted by injecting tagged fish into the selected turbines at Cabot and No. 1 Stations at or near full hydraulic capacity conditions for each test unit. Fish will be recovered from the tailrace, examined for injuries and held for 48 hours to determine latent mortality.

~~The feasibility of tagging juvenile shad with balloon tags will be investigated in Task 2. Should the feasibility effort prove actionable, five groups of juvenile shad will be tagged; the sample size for each group will be determined in consultation with the agencies. One group will be injected at each of the four passage routes, dam spill or gates, Station No. 1, Cabot Station and the downstream fish bypass. The final group will provide a control group and will be held in a 1000 gallon pump-through tank over the duration of the evaluation to investigate handling and tagging related mortality.~~

Task 4: Reporting

The hydroacoustic, radio telemetry and HI-Z Turb'N tag data will be analyzed relative to passage route(s) timing, frequency, magnitude and survival. This information will be compiled into a report and will include the methods used, results, a discussion and conclusions.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort will adequately address the study objectives. The estimated cost for the study is expected to be between $350,000 and $450,000, with much of the costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and HI-Z Turb'N tags, and related fieldwork labor).

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The peak out-migration of juvenile American shad typically occurs in September and October as water temperature cools. However, recent work conducted by O'Donnell and Letcher (2008) in the Connecticut River suggests that the emigration starts as early as the middle of August. As such, the hydroacoustic monitoring equipment will be deployed, calibrated, and tested in the first half of August becoming operational no later than August 15th. Study tasks will be conducted during the out-migration season, August 15 through the end of October, 2014.

Downstream American eel study (Study No. 3.3.5) will require hydroacoustic monitoring during roughly the same period because of overlap in the emigration periods of adult eel and juvenile shad. As such, these studies will be conducted concurrently, within the same study year, to take advantage of cost saving related to monitoring equipment rental, deployment, calibration, data management and analysis.

Because the study effort will be ongoing when the Initial Study Report is due to Stakeholders in September 2014, FirstLight proposes to provide Stakeholders with a study report supplement to summary downstream juvenile shad monitoring results in February 2015, followed by a meeting to discuss any potential additional information needs. The outcome of that discussion will determine if further study planning efforts are necessary for 2015.

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Harza Engineering Company &RMC Environmental Services, Inc. (Harza & RMC). (1993). Turners Falls Downstream Fish Passage Studies: Downstream Passage of Juvenile Clupeids, Fall 1992. Prepared for Northeast Utilities Service Company, Berlin, CT.

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3.3.4 Evaluate Upstream Passage of American Eel at the Turners Falls Project

General Description of Proposed Study

An evaluation of upstream American eel passage has been requested by USFWS, NHFG, MDFW, NHDES, VTDEC, CRWC, and TU. FirstLight proposes to complete a study to assess upstream American eel passage at the Turners Falls Project through trapping and visual observation of eel concentration areas. FirstLight anticipates conducting visual surveys for eel concentration areas in 2014 and using this information to inform trap placement in 2015.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to identify and assess potential locations for upstream American eel passage at the Turners Falls Project.

This study has two objectives:

- Identify concentrations of eels staging in pools or attempting to ascend wetted structures; and
- Assess whether eels can be passed in substantial numbers and whether sites are viable for permanent passage structures.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The goals of the Atlantic States Marine Fisheries Commission (ASMFC) management plan for American eel (2000) include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013). Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013).

In addition, the CRASC developed a Management Plan for American eel in the Connecticut River Basin in 2005. The goal of the plan is "*to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem.*" Management objectives in the plan include the following:

- Protect and enhance eel populations where they currently exist;
- Where practical, restore populations to waters where they had historical abundance;
- Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin, and;
- Comply with all requirements of the Fishery Management Plan of the ASMFC.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

While eels have been known to ascend the Turners Falls fishways, efficiency is unknown and they are typically operated only during the American shad passage season. Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the Turners Falls Project are unknown (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013).

The Holyoke Project has operated upstream eel passage facilities since 2004. In 2012, these facilities passed over 40,000 juvenile eels (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013). There is eel rearing habitat in the 35-mile reach between the Holyoke and Turners Falls Dams; however, it is likely that some eels will attempt to continue upstream to access habitat above the Turners Falls Dam.

Project Nexus (18 CFR § 5.11(d)(4))

The Turners Falls Project may directly impact upstream American eel as Project structures create impediments to migration.

The investigation area includes the following features of the Turners Falls Project:

- Cabot Station discharge area.
- Station No. 1 discharge area.
- Various canal discharge areas.
- Turners Falls Dam.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The study will be performed in accordance with the following methodologies.

Task 1: Systematic Surveys

Systematic surveys of eel presence and relative abundance will be conducted 10-12 times during the 2014 eel upstream migratory season. The first survey will be initiated within one week of eels being observed downstream of the project area at the Holyoke eel pass, with subsequent surveys occurring at night after precipitation events throughout the 2014 migration season. Each survey will consist of visual inspection on foot or by boat in areas where eels are likely to concentrate as they attempt to climb structures wetted by spill or leakage flow in the Turners Falls Dam complex area. The survey crew will use a red light if the water is not turbid and a white light when the water is deeper and more turbid to observe the eel; each site will be surveyed for at least 30 minutes. These locations, shown in Figures 3.3.4-1 and 3.3.4-2, include:

- ~~Cabot Station log sluice (downstream fish bypass).~~
- Cabot Station spillway (emergency water control gates).
- Cabot Fishway (dewatered state).
- USGS Conte Lab flume outfall.
- Station No. 1 outfall.
- Small turbine and process water outfalls from the Cabot Canal.
- Spillway fishway attraction water stilling basin.
- Leakage points along the downstream face of Turners Falls Dam (as site safety conditions allow).

Recorded data will include location, observation of eels (presence, absence) and relative numbers, relative sizes, behaviors, and time/date of observation, recent weather, and current discharge.

Task 2: Trap Collections

Areas identified in Task 1 as having eels present in sufficient numbers will be targeted as potential areas for permanent eel trap/passes and will be initially assessed using temporary/portable traps in 2015. At a minimum (regardless of survey results), temporary traps will be installed at the following locations in 2015:

- Cabot fishway attraction flow stilling basin (during dewatered fishway period),
- Station No. 1 discharge, and
- Spillway fishway attraction flow stilling basin (during watered and dewatered fishway period).

The temporary trap/passes will be designed and built for each location, and operated throughout the eel upstream migratory season, beginning within one week of eels being recorded at the Holyoke eel pass and continuing through October. Ramp-type traps with supplementary attraction flow will be used. Traps will operate daily (24 hours per day) and will be checked every two to three days to quantify the catch. Recorded data will include location, trapping interval, numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

The temporary trap/pass will be constructed of ¾-in marine plywood and will typically be 60 in long and 12-in wide with 72-in-long and 5-in-wide sides. A PVC spray bar will provide water for the ramp and attraction water will be provided by a siphon hose or pump hose with a minimum of 0.2 cfs attraction flow (Figure 3.3.4-1). Ramps will be less than a 35-degree angle and will be rigidly mounted to minimize movement and will be wetted with about 0.3 liters per second flow. A hopper large enough to prevent crowding will be deployed and at least 2 different sized substrate will be used side by side.

Eels collected from trap/pass collections will be transported to and released in the Turners Falls Impoundment.

Task 3: Data Analysis

All field data will be compiled, entered into a database, assured for quality, and archived. Tabular and graphic summaries of eel abundance by location will be developed.

Task 4: Reporting

A report will be prepared describing monitoring methods and results. The report will be submitted as part of the Initial Study Report as per the ILP process schedule.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The level of effort for Task 1 of the American eel study (Systematic Surveys) will include at least 10 to 12 evening surveying events. Cost of this effort including equipment is estimated to be $25,000 to $35,000. The 2015 effort to place temporary ramps at identified concentration areas and checking collection boxes on a routine basis (Task 2) will cost between $25,000 and $35,000. The total cost for this study ranges from $50,000 to $70,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Systematic surveys and trapping to evaluate eel presence and abundance will be conducted 10-12 times throughout the eel upstream migratory season (approximately May 1 to October 15, dependent on river temperatures and observations at the downstream eel pass) in 2014. Results will inform locations for installing temporary trap/passes during the same period during 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

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Figure 3.3.4-1: Approximate Locations of Systematic Eel Surveys near Turners Falls Dam.

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Figure 3.3.4-2: Approximate Locations of Systematic Eel Surveys near Cabot Station

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3.3.5 Evaluate Downstream Passage of American Eel

General Description of Proposed Studies

The USFWS, NHFG, MDFW, NOAA, VTDEC, TU, and CRWC have requested two specific studies regarding downstream passage of adult American eel. The first study request was for a timing evaluation of downstream migratory movements of American eel on the mainstem Connecticut River. The second study request was for an assessment of downstream American eel passage at the Turners Falls Project and Northfield Mountain Projects. The study proposed herein will use radiotelemetry and hydroacoustic methods to investigate the timing of silver phase eel outmigration in the Connecticut River in the Project area and routes of passage through the Projects. Additionally, HI-Z Turb'N tags will be used to empirically determine rates of survival for eels entrained at Station No. 1 and Cabot Station.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals of these studies are to:

1. Better understand migration timing of adult, silver-phase American eel as it relates to environmental factors and operations of the Turners Falls Project and Northfield Mountain Project.

2. Collect information to determine the impact of the Turners Falls Project and Northfield Mountain Project on the outmigration of silver eel in the Connecticut River.

Specific objectives of these studies are to:

1. Characterize the general migratory timing and presence of adult, silver-phase American eel migrating past the Turners Falls Project and Northfield Mountain Project relative to environmental factors and operations.

2. Quantify movement rates and proportion of eel passing downstream via various passage routes at the Turners Falls and Northfield Mountain Projects. For the Northfield Mountain Project, the study will evaluate the proportion of eel entrained into the intake. For the Turners Falls Project, the study will evaluate the proportion of eel passing via the available routes of passage.

3. Evaluate survival of adult silver eel passed at the available routes of passage at the Turners Falls complex.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Based on management plans developed by the ASMFC and the CRASC, the resource management goals identified by the commenting agencies are to:

- Ensure PME measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific goals with respect to downstream passage of American eel are to:

- Minimize current and potential negative project operation effects that could hinder management goals and objectives.
- Minimize project-related sources of downstream passage injury, stress, and mortality in order to maximize the number of silver eel migrating to the spawning grounds.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

According to the commenting agencies, data on the timing of downstream migratory movements and rates of American eel in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on the presence of "eel-sized" acoustic targets have been collected (Haro et al., 1999) within the Cabot Station forebay, supported by video monitoring at the Cabot Station downstream fish bypass. This was a short-term study, with acoustic monitoring performed between 17 September and 5 October and video monitoring conducted between 18 September and 22 October. Some daily monitoring of the downstream fish bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt Associates, 2005; 2006; Normandeau Associates, 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night

As discussed in the PAD, 2-D and 3-D telemetry studies were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eel entering the Cabot forebay become entrained through the Station turbines (90% in 2002, 100% in 2003; Brown, 2005; Brown et al., 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eel were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality. The approach velocity at the Cabot Station racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station No. 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. The intake at the Northfield Mountain Project has 48-foot-deep trash racks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station No. 1 or the Northfield Mountain facility have been conducted.

Existing research and literature on the American eel relevant to these proceedings includes the following:

Brown, L.S. (2005). Characterizing the downstream passage behavior of silver phase American eel at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts. Amherst, Massachusetts: University of Massachusetts.

Brown, L., A. Haro, and T. Castro-Santos. (2009). Three-dimensional movement of silverphase American eel in the forebay of a small hydroelectric facility. In J. Casselman et al. (Eds.), *Eel at the Edge: Science, Status, and Conservation Concerns* (pages 277-291). Bethesda, MD: American Fisheries Society.

Electric Power Research Institute (EPRI). (2001). Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eel at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

Haro, A. (2003). Downstream migration of silver-phase anguillideel. Pages 215-222 in: Aida, K., K. Tsukamoto, and K. Yamauchi, eds. Eel Biology. Springer, Tokyo.

Haro, A., D. Degan, J. Horne, B. Kulik, and J. Boubée. (1999). An investigation of the feasibility of employing hydroacoustic monitoring as a means to detect the presence and movement of large, adult eel (Genus *Anguilla*). S. O. Conte Anadromous Fish Research Center Internal Report No. 99-01. Turners Falls, Massachusetts. 36 pp.

Kleinschmidt Associates. (2005). *Factors influencing the timing of emigration of silver-phase American Eel, Anguilla rostrata, in the Connecticut River at Holyoke MA*. Submitted to the City of Holyoke, Holyoke Gas and Electric Department.

Kleinschmidt Associates. (2006). *Holyoke Project (FERC No. 2004) silver-phased American eel flow priority plan*. Submitted to the City of Holyoke, Holyoke Gas and Electric Department. 51 pp.

Normandeau Associates, Inc. (2007). *American eel emigration approach and downstream passage routes at the Holyoke Project, 2006*. Submitted to the City of Holyoke, Holyoke Gas and Electric Department. Final report. Westmoreland, New Hampshire: Normandeau Associates, Inc.,

Project Nexus (18 CFR § 5.11(d)(4))

Project operations may directly or indirectly affect eel outmigration in the fall through entrainment, rate of movement, injury, or mortality. Baseline information related to the timing and passage of outmigrating eel will allow stakeholders to assess project-related effects on eel migratory success and survival.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Information will be collected to assess potential impacts to adult eel outmigrants by project operations by a combination of approaches including hydroacoustic and radio telemetry, and the use of HI-Z Turb'N tags. The study objectives will be met by a tasked approach and are anticipated to occur in 2014.

Task 1: Evaluate Timing of Downstream Migratory Movements

The timing, duration, and magnitude of adult eel migration at the Turners Fall Project will be evaluated over a range of existing and operational conditions. Hydroacoustics will be deployed in the forebay area at Cabot Station, at the Gatehouse and the Northfield Mountain Project intake. An array of split beam transducers will be deployed to provide sufficient coverage of the cross-sectional targeted areas. The exact location and number of transducers, and orientation will be determined prior to the commencement of the survey during reconnaissance and test deployment, but will be established to optimize spatial coverage. To the extent possible, transducers will be mounted in areas of limited turbulence and ambient noise and away from eddies or other hydraulics where fish "milling" would occur. Ideally transducers would be mounted as close to the target area as possible.

Data will be recorded and archived continuously; however at the Northfield Mountain intake, only data recorded during pumpback mode will be analyzed. Depending on the configuration of the system and the target area, fish moving in the direction of the target area, fish size, or other sampled parameters can potentially be used to identify acoustic targets corresponding to adult eels. Acoustic targets can be filtered by size and supporting data used to apportion the number of fish by size class. The scope and details of such a study cannot be determined at this time but if needed, will be designed and executed in consultation with agencies. Current plans are to have the hydroacoustic expert on site in mid-August, 2013.

Data will be recorded by an onsite data logger. Transducers will be inspected and serviced by a qualified technician on a weekly basis, and data will be remotely downloaded and reviewed at least once per week during sampling to qualitatively view trends, and to ensure the system is functioning properly. During analysis, echo data will be analyzed using standard analytical tools such as Echoview ® software, and temporally related to concurrent station operation, water temperature, climatic conditions and Connecticut River flow. Data will be displayed in both tabular and graphic form, and include hourly daily, monthly and full season estimates. To the extent possible data output will also show patterns of spatial distribution of targets in the intake area. Data from the hydroacoustics will provide information on the timing, frequency and magnitude of the migration, as well as estimates of adult eel entering to and existing in the Canal and estimates of the numbers entrained at the Northfield Mountain Project. Eel outmigration through the downstream bypass will be sampled concurrently. Concurrent bypass sampling will be conducted over several discreet events (12 to 18) to ground truth the hydroacoustic data and compare the percent of eels passing via the Cabot sampler and Cabot Station. ~~Task 1 will be conducted in the first year of study (2014) and in tandem with the juvenile shad study (see Section 3.3.3). The timing of eel migration as it relates to environmental factors and operations of the Turners Falls Project and Northfield Mountain Project will be assessed through the use of hydroacoustic techniques. Hydroacoustic equipment will be installed within the Cabot Station forebay to provide information on the timing, magnitude, and duration of adult eel passage through this area. Because eels tend to concentrate in areas of dominant flow[36], the hydroacoustic zone to be monitored will target a portion of the dominant flow through the project (i.e., forebay intake area). Hydroacoustic monitoring will encompass the entire potential migratory season, beginning in mid-August and ending in mid-November. Data will be recorded for later processing and archiving. Concurrent sampling will also occur at the Cabot sampler on at least 10 evenings to ground truth the hydroacoustic data and compare the percent of eels passing via the Cabot sampler and Cabot Station.~~

~~In addition, project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, air temperature, and precipitation amounts) will be monitored following standard methodology throughout the duration of the studies.~~

One year of hydroacoustic sampling is being proposed. If the 2014 season is a typical flow/weather season, then that would conclude this effort. If the 2014 season is not typical, a second season would be considered based upon discussions with the resource agencies.

<u>Task 2: Assessment of Downstream Passage of American Eel</u>

FirstLight will assess downstream passage and entrainment survival of adult American eel through use of radio-telemetry techniques.

FirstLight will use radio telemetry techniques to monitor adult downstream eel passage at the Turners Falls Project and Northfield Mountain Project. For the Northfield Mountain Project, the study will evaluate the proportion of tagged eel entrained into the intake. For the Turners Falls Project, the study will evaluate the proportion of eel passing via spillways, gates, turbines, and the existing fish bypass at Cabot Station and/or Station No. 1. The route of passage study will be designed with the use of motion sensor telemetry tags that will give researchers an indication of passage-induced mortality.[37] This phase of the study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest to assess general routes of passage (i.e., via spill, fish passageways, or turbines).

[37]For example, if an eel goes into an immobile state for a period of 36 hours, the tag's code will be programmed to switch signal transmission patterns (e.g., to a different code or different burst rate).

Emigrating silver phase eels will be collected at the Cabot bypass sampler or the Holyoke Canal bypass sampler. Eels selected for tagging will meet morphometric (e.g., eye diameter relative to body size - Pankhurst Index of approximately 6.5 or greater) criteria to ensure they are migrant silver phased eels. Collections will be made within the migratory season (late August to mid-October), and eels will be tagged and released within 21 days of collection.[38] In addition, project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, water temperature, air temperature, and precipitation amounts) will be recorded throughout the duration of the studies.

Task 2a: Northfield Mountain Route Selection Study

Groups of eels will be tagged and released approximately 5 km upstream of the Northfield Mountain tailrace. Proposed sample sizes for this study have not been determined yet; FirstLight is still evaluating samples sizes and will determine appropriate sample sizes and provide justification for such prior to study execution in its revised study plan. At least three radio telemetry antenna will be placed near the intake area: in the immediate vicinity of the Northfield Mountain Project intake. Radio tagged eels released upstream by TransCanada will also be monitored through the Project area.

Task 2b: Turners Falls Dam Route Selection Study

Groups of eels will be tagged and released approximately 3 km upstream of the Turners Falls Dam. Groups of eels will be released over various spill conditions which will be determined based on results of the instream flow study (Study No. 3.3.1). Proposed sample sizes for this study have not been determined yet; FirstLight is still evaluating samples sizes and will determine appropriate sample sizes and provide justification for such prior to study execution in its revised study plan.

.Telemetry receivers and antennas will be positioned to monitor the following potential routes of passage:

- Within the power canal.
- Near the bascule gate(s).Within the bypass river channel.
- Turners Falls spillway fishway attraction water intake (if operational).
- Station No. 1 intake.
- Cabot Station log sluice (downstream fish bypass).
- Cabot Station spillway (emergency water control gates).
- Cabot Station intake.
- Route 116 Bridge.

Location and number of receivers/antennae may be modified during study set-up due to conditions encountered in the field; however, the intent is to monitor the above-named potential routes of passage. Aerial yagi and/or droppers will be used. Eels released above the Northfield Mountain intake that enter

[38] The timing of collection, tagging, and release will be entirely dependent on migratory patterns and weather/river conditions. All tagged eel will be released at night during inclement weather or with inclement weather pending to increase the likelihood that eel will move soon after release. Though FirstLight will target a seven-day hold period, riverine conditions may not be adequate for release, and therefore hold times may last longer than seven days. Migratory movements of silver eel have been noted after hold periods longer than seven days during several recent radio-telemetry studies at hydroelectric facilities in the northeast [(see FERC projects P-2364 (Abenaki), P-2365 (Anson), P-2325 (Weston)].

the lower end of the Turners Falls Impoundment (i.e., not entrained at Northfield Mountain) will be used to supplement the release groups.

Task 2c: Mobile TrackingMobile tracking (i.e., via boat, vehicle, or by foot) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up. Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

Tags will be programmed to transmit on several different frequencies to avoid interference or tag signal collision. Tag pulse will likely be programmed at 2 second intervals with a battery life of at least 50 days. Prior to release of tagged eel, FirstLight will perform testing and range verification to minimize overlap of detection fields while maximizing detection range. As needed, beacon transmitters will be employed at strategic locations to provide a repeated data stamp during the study to verify receiver functionality.

Task 3: Data Management and Analysis

Data from hydroacoustic timing studies (Task 1) will be collected in the field and transferred to an electronic format. All data entry will be assured for quality. These data will be processed with Myriax Echoview or similar software. The data will be reduced by applying an intensity threshold that is representative of the target size and analyzed with an α,β-tracking algorithm, which identifies the series of echoes that were returned by an individual fish over successive pings. The tracking results will be reviewed on the echogram and exported as a database containing time, target strength, and 3-D positional information for each fish detected. An expansion factor will be calculated for each individual eel as a function of its effective beam width at the range it was observed. This effective beam width depends on the acoustic beam pattern and the size of the target. The expansion factor compensates for this differential detection probability.

Data from the adult eel telemetry study (Task 2) will be collected regularly from the field during the study periods (i.e., at 2 to 3 day intervals). Data will be archived and entered into an MS Access or MS Excel database for sorting and post-processing. All data entry will be assured for quality. To the extent possible, routes of passage will be determined. Route determinations will be based on the sequence of individual eel detections at the antenna arrays. Additionally, route-specific survival will be determined by analysis of the sensor tag data, which will indicate whether an eel has resumed typical migratory behavior after passing downstream or has not survived passage.

Task 4: Turbine Survival

HI-Z Turb'N tags will be used to empirically determine rates of survival for eels entrained at Station No. 1 and Cabot Station. As currently envisioned, a total of 150 tagged eels will be released into turbines. FirstLight is still evaluating samples sizes and will confirm appropriate sample sizes and provide justification for such prior to study execution in its revised study plan. The tagged eels will be proportionally allocated by the number of different turbine types at Station No. 1 and Cabot Station. All six turbines at Cabot Station are similar type and hydraulic capacity so testing will be conducted at one turbine at Cabot Station as a representative unit. Data for that unit will be extrapolated to calculate a total station survival rate. Station No. 1 has five Francis style turbines. Four of the five turbines are similar in speed, hydraulic capacity (490 to 560 cfs) and one is smaller (140 cfs). Testing will be conducted at two turbines at Station No. 1 (at one to represent the four larger units and at the smaller capacity unit). Like Cabot, the data for the representative unit will be extrapolated to calculate a total survival rate for all four units and combined with the data for the smaller unit for a total station survival rate. Tests will be conducted by injecting tagged eel into the selected turbines at Cabot and No. 1 Stations at or near full hydraulic capacity conditions for each test unit. Fish will be recovered from the tailrace, examined for injuries and held for 48 hours to determine latent mortality.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Projects on downstream passage and timing of adult eel in the investigation area. The estimated cost for this study is approximately between $350,000 and $450,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Because the study effort will be ongoing when the Initial Study Report is due to Stakeholders in September 2014, FirstLight proposes to provide Stakeholders with a study report supplement to summarize downstream adult eel monitoring results in February 2015, followed by a meeting to discuss any potential additional information needs. The outcome of that discussion will determine if further study planning efforts are necessary for 2015.

3.3.6 Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

General Description of Proposed Study

The following stakeholders requested studies to investigate the impact of project operations on shad spawning, spawning habitat and egg deposition within the project boundary: USFWS, MADFW, NHFGD, NHDES, CTRWC, NOAA, the Town of Gill, TU, and VTDEC. Section 4.4.5 of the PAD identifies several migratory species of fish that seasonally occur in the aquatic habitat within the Project boundary. One such species, the American shad (shad), migrate into the Connecticut River to spawn, reaching Project waters in late April or early to mid- May. Much of the river downstream of Cabot Station is suitable for shad spawning, and the reach of the Connecticut River including the Deerfield River confluence is thought to be particularly productive spawning habitat. The study described herein will gather data to determine the effects of operational changes and subsequent flow/water level fluctuations on spawning shad in the Connecticut River.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

Determine if project operations (under the permitted and proposed operational ranges) affect shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches that extends from the base of Vernon Dam to the Route 116 Bridge in Holyoke..

Specifically, the shad spawning study will:

- Determine areas utilized by shad for spawning by conducting night-time visual and aural observation of spawning activity;
- Identify and define those areas geospatially, and obtain data on physical habitat conditions affected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Collect information in order to assess project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity; and
- Verify spawning activity as measured by night-time spawning/splash surveys in areas of spawning activity, and downstream of these areas, to gather data to determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The CRASC was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138).

CRASC developed *A Management Plan for American Shad in the Connecticut River Basin* in 1992. Management Objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, aims to maximize the number of juvenile recruits emigrating from freshwater stock complexes through the following objectives:

- To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
- Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
- Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
- When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations, to enhance river habitat.

The resource agencies' goals related to aquatic natural resources include:

- Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.
- Conserve, enhance, and restore natural communities, habitats, and species and the ecological processes that sustain them.
- Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.
- Ensure that PME measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Turners Falls Project.

The resource agencies' goal specific to American shad is:

- Minimize current and potential negative project operation effects on American shad spawning and recruitment.

The agency requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and PME measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R.794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time. The number of shad lifted at Holyoke reached 721,764 in 1992 and the overall Connecticut River shad population exceeded 1.6 million shad in that year(CRASC 1992). In most years, however, the shad population has not reached CRASC management plan objectives. Likewise the number of shad passing Turners Falls Dam has not met the CRASC objective.

In preparation of the PAD, fisheries data were compiled on the shad resources in the Connecticut River; the data can be found in section 4.4.5 of the PAD. American shad seasonally migrate into the Connecticut River in the spring, late March or April, to spawn; typically reaching Project waters by late April to mid-May when river flow is generally declining from the spring peak. Shad passage has been monitored at the Holyoke Dam (Figure 4.4.5-1 of the PAD) and these counts provide a comprehensive record of the number of shad that have access to Project waters. Population number and passage numbers past Holyoke have declined from the 1992 peak described above, with average Holyoke passage numbers over the last ten years of 211,850. However, shad numbers have been on the rise since 2005 with over 490,000 shad passing Holyoke Dam in 2012.

American shad typically spawn in water ranging from 3 to 18 ft in depth, in run or glide habitat (FirstLight, 2012). Shad typically spawn at night, with males reaching spawning areas prior to females (Greene et al., 2009). Daytime spawning has been documented on overcast days or in turbid water when light intensity is somewhat diminished (Greene et al., 2009). Females are broadcast spawners, preferring to release their eggs over course substrates including cobble, gravel and sand (Greene et al., 2009 and FirstLight, 2012). American shad are highly fecund and spawn repeatedly as they move up river (Greene et al., 2009). They exhibit asynchronous ovarian development and batch spawning with multiple females releasing their eggs at the surface where they will be fertilized by one or more males. The act of spawning can be conspicuous and vigorous, with spawning individuals breaking the surface.

Most (~77%) of the 30 mile reach below Cabot Station consists of *run* mesohabitat type with coarse substrates; presence of glide habitat areas are negligible (FirstLight, 2012a). Though habitat suitable for shad spawning is abundant in the 30 mile reach downstream of Cabot Station, the area of the Connecticut River, in the vicinity of the Deerfield River confluence, is thought to be particularly productive. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7, below the Mill River confluence in Hatfield, MA. The upstream extent of this range is in close proximity (~ 0.7 miles) to Cabot Station and experiences flow changes resulting from Station operation.

In 2012, FirstLight conducted studies in the late spring and summer to examine habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD).

Project Nexus (18 CFR § 5.11(d)(4))

For the purposes of this study plan the Study Area includes the Connecticut River in reaches downstream from Cabot Station to the upper extent of the Holyoke impoundment and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Project operations.

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer, 1974).,

Shad spawning is likely influenced by river flow, among other environmental factors such as water temperature. Flow fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While several shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. There are no known studies of the relationship between spawning behavior, habitat use, and egg deposition and Turners Falls and Northfield Project operations Continued Project operation and maintenance activities could, through the manipulation of flow, affect American shad that utilize the project area for spawning. The Agencies are concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets. This study will provide information regarding the availability and location of shad spawning habitat and the effect on spawning activity of flow changes caused by Project operation.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

FirstLight will investigate shad spawning within the study area to determine how operations at Cabot Station may affect shad spawning behavior. The investigation will include a review of existing information relative to shad spawning in the Connecticut River and a visual and aural survey of the study area to locate spawning areas and evaluate the effect of Project operations on spawning.

The field studies will focus on known spawning areas downstream of the Turners Falls Project (to the Route 116 Bridge). No previous studies have attempted to locate spawning areas upstream of Turners Falls Dam. Additionally, the field effort will include surveying the impoundment (up to the Vernon Dam) for evidence of shad spawning.

Field study locations will be determined by review of existing information and hydraulic modeling,; therefore, FirstLight will consult with Stakeholders to review results of Task 1, as outlined under the Study Schedule section below.

~~The field studies will examine known spawning areas downstream of the Turners Falls Project, to determine operation effects on shad spawning behavior, activity, and success. Further, areas utilized for spawning by American shad will be identified in the reach of the river upstream of Turners Falls Dam extending to the Northfield Mountain Project.~~

Task 1: Development of a Detailed Study Schedule

As a first step, historic data pertaining to Cabot Station discharge and flow data will be collected to provide the basis for determining typical flow regimes during the study period. Operational data from the previous ten years of generation will be reviewed to determine how the station has historically operated during the shad spawning season. Historical data from the USGS gage located on the Connecticut River in the City of Montague (USGS 01170500) and the Deerfield River (USGS 01170000) near the town of West Deerfield, Massachusetts will be reviewed in conjunction with station operation data. It is important to show the magnitude of flow and corresponding water level fluctuation in the Connecticut River below Cabot Station when flows exceed the hydraulic capacity of the Turners Falls Project. Similarly, it will be important to show the same when flows are within the hydraulic capacity of the Turners Falls Project.

FirstLight is developing a hydraulic model of the Connecticut River from the Turners Falls Dam to the Holyoke Dam- see Study No. 3.2.2 *Hydraulic Studies of Turners Falls Impoundment, Bypass Reach, and below Cabot Station*. The hydraulic model developed for the reach between Turners Falls Dam and Holyoke Dam will be used to further inform this study. More specifically, the hydraulic model will simulate water elevations in this reach under the historic flow ranges during the spawning season. Flow data will be obtained from the Montague USGS gage. The model will be run in an unsteady mode to simulate the peaking operations of the Turners Falls Project during the spawning season. The intent of the modeling is to understand the relationship between the magnitudes of water level fluctuations due to peaking operations within the context of flows normally present during the spawning season. The hydraulic model and previous water level data collected at Route 116 Bridge and at Rainbow Beach may also place bounds on the geographic extent of the study. For example, peaking operations may have a greater impact on the magnitude of water level fluctuations closer to Cabot Station than further downstream. Based on the water level monitoring conducted at the USGS gage in Montague, Route 116 Bridge and at Rainbow Beach, the magnitude of water level fluctuation decreases and attenuates further downstream. The results of the hydraulic model will also provide an indication of areas that potentially become dewatered under certain operational scenarios. Should any of these areas be located downstream of identified or suspected spawning areas, ichthyoplankton nets will be deployed to determine if shad eggs are present and susceptible to desiccation when water levels decrease due to operational changes.

Further, counts of shad passed at the Holyoke Dam and Turners Falls will be tracked to pinpoint the most effective timing of field surveys. Concurrent adult shad telemetry studies may also provide insight as to the location of spawning shad.

Task 2: Examination of Known Spawning Areas Downstream of Turners Falls Dam

Field surveys will be conducted in two phases at night from shore or primarily by boat during periods of anticipated spawning and will be based on information collected in Task 1; Phase 1 will identify locations where shad are actively spawning, and information will be collected to evaluate project effects in Phase 2. In the study area, spawning typically occurs between early May to mid-June, when water temperatures reach 13-18ºC (Collette and Klein-MacPhee, 2002). Field surveys of spawning activity will commence during this period (approximately early May) or after a minimum of 10,000 shad have passed the Holyoke Project. The level of effort will be dependent on the density of spawning shad within the study area, with initial surveys to be conducted twice weekly and will be increased to three times per week during peak spawning..

Surveys conducted below Cabot Station will concentrate on the five known spawning locations downstream of the Deerfield River confluence (river mile 191.9) (Layzer, 1974; Kuzmeskus, 1977).

Phase 1 of the surveys will employ methods described by Ross (1993). Adult spawning shad will be observed and quantified by counting spawning splashes over 15-minute intervals between sunset and 01:00 hours. Once splashes have been observed for a 15-minute interval, the survey crew will progress to the next known spawning area for observations. The amount of time spent at each spawning area will be subjectively determined by the field survey crew, but will be such that all of the known spawning areas are observed between sunset and 01:00 hrs. Spot lights will be used to verify that such splashes were made by spawning American shad. The species and number of fish observed and their behavior will be recorded. We assume that, though every splash may not represent actual spawning and every spawning may not be accompanied by a splash, the level of surface activity is strongly correlated with actual spawning (Ross et al., 1993). Other parameters to be measured during observed spawning events include; spawn timing and location (GPS); water temperature, dissolved oxygen (DO), pH, conductivity, turbidity, depth and surface velocity; and predominant substrate type. All data will be recorded on a dedicated data sheet. The data sheet will include aerial reference images and/or maps of the study area to document the relative position of observed spawning shad and provide the information necessary to estimate the total area used for spawning as well as an index of spawning activity. The data collected in the field will be correlated to Cabot Station discharge and river flow as a function of time.

In Phase 2, the impacts of flow fluctuation on spawning shad will be investigated during the peak spawning period at locations identified in Phase 1 that may become dewatered when water elevations decrease due to operational changes at Cabot Station, as indicated by the hydraulic model. These areas will be targeted for observations during periods of discharge fluctuation at Cabot Station. Prior to flow manipulation, data (including splash observations, water quality parameters, depth, surface velocity, predominant substrate type, and location) will be collected to provide a baseline of shad spawning rate. FirstLight will then manipulate discharge at Cabot Station to investigate impacts to spawning. Shad spawning rate will be investigated over a range of expected seasonal flow fluctuations based on historic discharge data at Cabot Station. Several discharge manipulations may be investigated but will begin with the most extreme fluctuations scenarios. Baseline spawning rate and behavior will be compared to those observed during periods of flow manipulation to investigate potential impacts to spawning. In addition, based on the results of the hydraulic model and Phase 1 of the spawning survey, ichthyoplankton nets will be deployed downstream of suspected spawning areas that may potentially become dewatered during operational changes to determine if shad eggs are present and susceptible to desiccation. The 1-meter -long ichthyoplankton nets will be of 500 micron mesh or smaller and anchored in place for 1 hour, depending on ambient conditions. At the end of the sampling event, the nets will be retrieved and the contents will be preserved for subsequent analysis and identification of shad eggs. Identification of shad eggs will be in accordance with existing literature and will rely on methods of Ross and Bennet (1993) for distinction from white sucker eggs.

Task 3: Identification of Spawning Areas Upstream of Turners Falls Dam

Less is known about spawning locations upstream of the Turners Falls Dam; and the study described herein should provide insight on spawning locations upstream within the study area (to the Vernon Dam). As such, upstream surveys will target areas of suitable aquatic habitat for shad spawning, including those containing flowing waters over coarse substrates. The methodology for these surveys will focus on identifying spawning areas via splash surveys consistent with Phase 1 of Task 1.

Task 4: Examination of Identified Spawning Areas Upstream of Turners Falls Dam

Further investigation of spawning areas identified upstream of the Turners Falls Dam (to the Vernon Dam) in Task 3 will be performed with methodology consistent to that utilized for Phase 2 of Task 2. Additionally, if results of the hydraulic model indicate that areas downstream of the spawning locations may be exposed when water elevations decrease, ichthyoplankton nets will be deployed to determine if shad eggs are present and susceptible to desiccation. As discussed above, a review of the previous ten years of Project operational data will allow for the determination of appropriate operating scenarios for which sampling will occur.

Task 5: Data Analysis and Reporting

Information collected during this study will be compiled and presented in a report, which will include a map of the study area depicting the locations of observed spawning shad; materials and methods; results; a discussion of observed spawning behaviors; and, if applicable, impacts due to operational changes.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort will adequately assess the potential effects of continued Projects operations on spawning shad and their habitat within the study area. One year of the study is anticipated to cost between $70,000 and $90,000. Should a second year of study be required, year two cost is anticipated to be between $50,000 and $60,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Due to the iterative nature of the study tasks that need to occur prior to field investigations, FirstLight proposes to utilize an ongoing consultation process with Stakeholders. This will provide Stakeholders with an opportunity to review results of Task 1 and to provide input on specific known and likely spawning locations to be visited in the field. The following study and consultation steps/estimated timeframes will be the following:

- FirstLight to conduct Task 1 – October 2013 through December 2014 (it is anticipated that results of hydraulic modeling and IFIM study will be compiled in the fall 2013 timeframe sufficient to be considered under this task to identify operating regimes under which field studies will be conducted)
- Distribute results of Task 1 and proposed locations for field investigation of known and anticipated spawning locations – January 2014
- Hold meeting with Stakeholders to review desktop analysis and reach consensus on field study locations – February – March 2014

Conduct field studies of spawning locations during the 2014 spawning season, May to mid-June. The exact timing of the field survey will depend on a variety of seasonal and site specific factors but water temperature is the primary factor that triggers spawning. Other factors include photoperiod, water flow and velocity, and turbidity. The timing of the survey will be further refined using information obtained from shad passage data collected downstream at the Holyoke Project fish lift and Turners Falls Project fish ladders. Further, information collected during concurrent shad migration investigations may also provide insight to the locations and timing of spawning.

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3.3.7 Fish Entrainment and Turbine Passage Mortality Study

General Description of Proposed Study

The following stakeholders requested a field study to assess fish entrainment from the Connecticut River at the Northfield Mountain Project: USFWS, NMFS, NHFG, MDFW, CRWS, TU, and Town of Gill, MA. The requested objective is to quantify the number of resident and migratory fishes entrained on an annual basis as a means to evaluate potential impacts to riverine fish populations in the Turners Falls Impoundment and transient diadromous fish populations passing though the study area. The FERC has requested a literature-based assessment of fish impingement, entrainment and survival at the Northfield Mountain and Turners Falls Projects.

Entrainment field studies of the type requested by the agencies, by themselves, provide only an estimate of annual turbine fish passage and survival, but are not sufficient to determine population-level impacts on riverine resident fish populations (FERC, 1995). In recent years, desktop entrainment analyses have been found to be adequate by the FERC for characterizing annual fish entrainment loss at hydroelectric projects. Therefore, FirstLight proposes to conduct a *desktop* fish entrainment and turbine mortality assessment of the Northfield Mountain Project. For the purposes of this desktop entrainment mortality assessment, the study area includes the Turners Falls Impoundment and the Northfield Mountain Project.

The proposed study described herein will assess the potential entrainment and turbine mortality risk of both resident and diadromous fish species within the study area. This assessment will be supplemented by radio telemetry studies of American shad and American eel proposed under other study plans (see Study Nos. 3.3.2, 3.3.5, and 3.3.6), which will provide information necessary to evaluate the impacts of entrainment and turbine mortality as a result of continued Project operation.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to assess fish impingement, turbine entrainment, and turbine passage survival at the two Projects.

The specific objectives of this proposed study include:

- Estimate the potential impacts of entrainment, impingement, and turbine mortality on fish at the Northfield Mountain Project and Turners Falls Project by developing a qualitative scale of entrainment risk for resident and migratory fish species.
- Conduct a quantitative assessment of the potential impact of entrainment and turbine mortality of American shad and American eel.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The Connecticut River is home to riverine species of fish and also serves as a migratory corridor and spawning and rearing habitat for diadromous species such as Atlantic salmon and American shad. In 1967, Federal (USFWS and NMFS) and state (VT, NH, MA, CT) agencies formed a cooperative program called the Connecticut River Anadromous Fish Restoration Program (Restoration Program). The goal of the Restoration Program is to restore anadromous fish to the Connecticut River. In 1983, Federal legislation passed and gave jurisdiction over the Restoration Program to the CRASC, which also continues to work toward American shad restoration in the Connecticut River under the jurisdiction of the Restoration Plan. Agency study requests indicate that investigating the potential impacts of continued Project operation on fisheries resources in the study area will provide the necessary baseline information to evaluate the need for mitigation measures.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In preparation of the PAD, existing information was compiled regarding the physical characteristics of the Northfield Mountain Project and Turners Falls Project to be evaluated. Factors that affect the potential for entrainment at a hydroelectric project include the size and depth of the intakes, the hydraulic capacity and configuration of the turbines, the velocity of water as it enters the intake relative to fish swim speeds, the location of the intake relative to fish habitat, and the characteristics of fish species present in the study area. Further, the PAD identified those fish species that are likely to occur in the study area and, therefore, may be potentially susceptible to entrainment and turbine mortality. The fish assemblage within the study area is comprised of both riverine and diadromous species. For more information regarding the local and transient fish assemblage please see section 4.4.5 of the PAD.

Prior entrainment studies conducted at the Northfield Mountain Project include an entrainment study targeting juvenile American shad in 1992 (LMS, 1993), a strobe light exclusion efficiency study (Cook, et al., 1994) and a guide net exclusion efficiency study (NUSCO, 1999). These studies were conducted to evaluate and mitigate the impacts of the Project operation on anadromous fish species in the Connecticut River. Methods included radio telemetry, entrainment netting, and mark/recapture to investigate the probability of entrainment, and did not investigate turbine mortality.

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991, 1992, and 1993 (Harza & RMC 1992; 1993; RMC 1994) which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines.

Project Nexus (18 CFR § 5.11(d)(4))

Continued Project operation could potentially affect riverine and migratory fish species that utilize the aquatic habitat within Project area. This study will provide information regarding the local and migratory fish assemblage that is likely to occur in the Project area, and thus be susceptible to entrainment and turbine mortality at the Northfield Mountain Project and Turners Falls Project. This information will provide insight on the effects of continued Project operations to the fisheries resources in the Project area.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The proposed study methodology involves both a qualitative and quantitative approach to characterizing and estimating fish entrainment for the Northfield Mountain Project and Turners Falls Project. Entrainment magnitude and turbine mortality will both be evaluated. A qualitative approach will utilize a desktop entrainment analysis of resident fish species entrainment, whereas a quantitative approach will be specific to adult and juvenile American shad and adult American eel.

Task 1: Qualitative Assessment of Entrainment and Impingement

Fish dwelling in, or migrating through the Turners Falls Project area may potentially be subject to entrainment at Cabot, Station Number 1, or the Northfield Mountain Project (during pumpback). A qualitative scale of entrainment potential ranging from "Low" to "High" will be developed for each resident fish species documented as existing in the Turners Falls Impoundment during the baseline fish assemblage assessment (Study No. 3.3.11). This approach provides reasonable seasonal and annual estimated entrainment risk estimates for fishes of three size groups, small (<8"), medium (8-15") and large (>15"). River resident species composition and length frequency distribution will be derived from site-specific fish survey data collected in the Turners Falls Impoundment as part of Study No. 3.3.11.

Assessing the probability of entrainment will include an examination of the biological, habitat, and engineering/operational characteristics of the Northfield Mountain Project and Turners Falls Project relative to life history and behavioral traits of key species. These factors, and reviews of past entrainment reports (FERC, 1995, EPRI, 1997), suggest that resident species entrainment rates are generally influenced by these variables:

- **Intake proximity to shoreline:** Near-shore intakes typically entrain fishes at higher rates than offshore intakes, as fish tend to concentrate in littoral areas, and/or follow shorelines or orient to physical structure associated with shorelines.
- **Intake location in littoral zone:** The littoral zone is the most productive region of a reservoir and most fish rear in the shallower littoral areas.
- **Abundant littoral zone species:** Fishes such as centrarchids that spawn, rear, and spend most of their lives in shallow near-shore waters tend to be among the most abundant species in a fish assemblage.
- **Abundant resident clupeids:** Entrainment rates trend highest at projects with clupeids such as gizzard shad and threadfin shad.
- **Presence of obligatory migrants:** Resident fishes are usually entrained relative to their use of near-intake habitat. Migrants into or out of freshwater systems must locate a passage or exit route such as turbine intakes or draft tubes. Such structures provide the flow cues used by migrating fish and may attract such fish if no other flow outlets are present.
- **Shallow intake depth:** Fish are usually more abundant in shallower portions of a reservoir throughout most of the year.
- **Large hydraulic capacity:** More water passed through intakes relative to project inflow or impoundment volume will potentially present a higher entrainment risk.
- **High approach velocity:** Approach velocities may positively correlate with entrainment risk. Resident species may become involuntarily entrained if intake velocities exceed their volitional escape swimming speed.

FirstLight will develop a summary of the life history traits and habitat requirements of key resident species as they relate to these factors affecting entrainment at the Northfield Mountain Project and Turners Falls Project. Habitat use, swimming performance, behavior, and life stages, for example, are factors affecting the entrainment potential. This process will index species and lifestages of resident fish that are across a range from most to least prone to involuntary entrainment. The potential for entrainment of the most susceptible species will be assessed by comparing swim speed to intake velocity.

Impingement is defined as the involuntary contact and entrapment of fish on the surface of an intake trashracks. Impingement on an intake trashrack may result in injury or death for fish. After determining which fish species have the potential to be present in the area of the intake structures an analysis will be performed to estimate the body length and width of fish that would be physically excluded by the bar rack spacing at each intake structure, and, thus, at risk for potential impingement.

Task 2: Quantification of Shad and Eel Entrainment

FirstLight proposes to quantify entrainment rates of American shad and American eel at Cabot Station, Station No. 1 and Northfield Mountain. Entrainment rates (*i.e.* the percentage of fish entrained through a given structure) at Cabot and Station Number 1 will be derived from data collected during proposed tagging and hydroacoustic studies (Study Nos. 3.3.2, 3.3.3, and 3.3.5). Annual entrainment of American shad and American eel at Northfield Mountain will be estimated through hydroacoustic monitoring of the pumpback intake area during the period May through October when adult and Young of Year (YOY) American shad may be in the vicinity of the Northfield Mountain intake. An array of split beam transducers will be deployed to provide sufficient coverage of the intake cross-sectional area. The exact location and number of transducers, and orientation will be determined prior to the commencement of the survey during reconnaissance and test deployment, but will be established to optimize spatial coverage. To the extent possible, transducers will be mounted in areas of limited turbulence and ambient noise and away from eddies or other hydraulics where fish "milling" would occur. Ideally, transducers would be mounted as close to the trashracks as possible. A frequency in the 333 to 430 kHz frequency range will be used to reduce avoidance behavior of shad.

Data will be recorded and archived continuously; however, only data recorded during pumpback mode will be analyzed. Depending on the configuration of the system and the intake, fish moving in the direction of the intake, fish size, or other sampled parameters can potentially be used to identify acoustic targets corresponding to shad. Acoustic targets can be filtered by size and supporting data used to apportion the number of entrained fish by size class. Echo characteristics that separate juvenile shad and adult eels from other species will be ground-truthed by concurrent sampling to be conducted over several discreet events (12 to 18) at the Cabot Station and Cabot bypass.

Data will be recorded by an on site data logger. Transducers will be inspected and serviced by a qualified technician on a weekly basis, and data will be remotely downloaded and reviewed at least once per week during sampling to qualitatively view trends, and to ensure the system is functioning properly. During analysis, echo data will be analyzed using standard analytical tools such as Echoview ® software, and temporally related to concurrent station operation, water temperature, climatic conditions and Connecticut River flow. Data will be displayed in both tabular and graphic form, and include hourly daily, monthly and full season estimates. To the extent possible data output will also show patterns of spatial distribution of targets in the intake area.

Task 3: Estimation of Turbine Mortality

Turbine mortality may occur due to collision with blades wicket gates, or vanes, shear forces, and/or pressure changes. Turbine mortality will be assessed in several different ways.

For the Turners Falls Project, mortality for resident fish species will be estimated from literature values. Turbine passage survival studies have been independently performed at numerous hydroelectric projects throughout the country (Franke et al., 1997) for a wide range of salmonid, alosid, anguillid, and other freshwater fish species. Most studies have been conducted across a range of sizes of both propeller/Kaplan, as well as Francis turbine designs, using a variety of mark-and-recapture techniques. As a result, quantitative turbine mortality estimates can be derived from strike probability equations based on the design characteristics of Project turbines and the relative sizes of subject fish. Suitable source studies will be selected for transfer of turbine mortality data for each Project turbine. Data will be selected from source studies involving turbines of similar design and engineering parameters, and similar or identical fish species and size classes. Applicable turbine survival data will be obtained from the literature, and associated field data collected from the studies listed above, and used to estimate fish turbine passage mortality. The following turbine characteristics will be used as criteria in this analysis:

- Turbine design type
- Operating head
- Runner speed
- Turbine diameter
- Blade number and spacing
- Peripheral runner velocity

Mortality of American shad and American eel will be evaluated based on site-specific data generated by Study Nos. 3.3.2, 3.3.3, and 3.3.5, and supplemented by applicable literature data. Entrainment loss will be estimated by multiplying fish entrainment rate estimates by turbine mortality rates for both species (and multiple life-stages, where applicable).

Fish mortality occurring during pumpback at the Northfield Mountain Project can theoretically be estimated based on blade strike probability literature. However, this would estimate "once through" mortality, though some surviving fish may be subjected to multiple passes through the Project. If surviving fish recruited to the reservoir are re-entrained, additional incremental mortality would potentially occur. Insufficient information exists to portray residency time of fish in the upper reservoir or predict the percentage of surviving fish recruited to the reservoir re-entrained during subsequent generation, and/or pumped back again. Therefore, for purposes of this analysis, FirstLight proposes to conservatively assume that all fish entrained during pumpback experience mortality. For Northfield Mountain, the reported entrainment rate will be estimated based on number of hours pumping vs. generating or idling. Entrainment/mortality during pumping will be evaluated in the context of operating hours in each mode.

Task 4: Reporting

Results will be presented in a summary report, and will be discussed in regards to overall effects to fish populations based upon fish assemblage structure results from Study No. 3.3.11 along with fish passage count data. A tentative table of contents for this study will include:

- Introduction
- Methodology
- Description of Project Features
- Fisheries Community
- Susceptibility to Entrainment and Impingement
- Quantitative Results for American shad and American eel
- Effects of Entrainment and Impingement on Fish Populations
- Conclusions

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort will adequately assess the rate of entrainment and turbine mortality at the Northfield Mountain Project and Turners Falls Project. The proposed approach is consistent with methods accepted by FERC at other hydroelectric projects, such as the Muddy Run Pumped Storage Project (P-2355), Conowingo Project (P-405), Niagara Power Project (P-2216), and the St. Lawrence-FDR Power Project (P-2000); the study will provide information necessary to assess potential impacts of continued project operation on fisheries resources within the study area. The estimated cost for this one-year study effort will be approximately $50,000 to $60,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. Because a portion of this study draws upon data from radio telemetry and baseline fish assemblage studies, this assessment will be completed upon analyses of the field-based studies.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

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3.3.8 Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

General Description of Proposed Study

The USFWS, NHFG, MDFW, NOAA, CRWC, and TU requested a study utilizing Computational Fluid Dynamics (CFD) Modeling in the vicinity of the fishway entrances and the powerhouse forebays to evaluate flow field conditions. The Turners Falls Project consists of two hydroelectric facilities, Station No. 1 and Cabot Station, which utilize flow from the power canal to generate power. Migratory and resident fish may reside in the canal throughout the year. Upstream fish passage at the Project consists of three passage structures: the "Spillway ladder" (located at the Turners Falls spillway), the "Gatehouse ladder" (located at the Turners Falls Dam gatehouse), and the "Cabot ladder" (located at Cabot Station). These fish ladders provide an opportunity for upstream passage to migratory and resident fish. Downstream passage at the Turners Falls Project include over the dam, through the powerhouses, or through the downstream fish passage sluice adjacent to Cabot Station. CFD modeling in the vicinity of the fishway entrances and powerhouse forebays is proposed to evaluate flow field conditions.

Bathymetry surveys, required for the CFD models, will be conducted at the Spillway and Cabot fishway entrances and in front of the two powerhouse intakes (Figure 3.3.8-1). The bathymetric data collected from these surveys will be used to develop three-dimensional CFD models. Once developed, various model production runs will be executed to analyze the hydraulic characteristics (depth, velocity) found in these areas.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The study goal is to obtain information to determine the flow field conditions that exist in and around the fishway entrances, and in the upstream vicinity of the Cabot Station and Station No. 1 intakes.

1) ~~ssist in designing effective upstream fishways;~~

2) ~~Evaluate ways to reduce impingement, entrainment and delay for downstream migrating fish;~~

3) ~~Direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream bypass; and~~

4) ~~Maximize the number of upstream migrating fish that find and enter the fishway entrances.~~

The study objectives are to:

1) Map bathymetric data for the entrances of the Spillway ladder, Cabot ladder, Station No. 1 intake and Cabot intake. FirstLight is not proposing CFD modeling at the Gatehouse ladder as such modeling was recently completed (Alden, February 2012). The Alden report summarizing CFD modeling at the Gatehouse ladder can be found in Appendix F;

2) Develop three-dimensional CFD models of:

    a. The power canal in front of the Station No. 1 powerhouse intakes;

    b. The power canal in front of the Cabot Station powerhouse intakes;

    c. The Cabot fishway entrance; and

   d. The spillway fishway entrance[39]

3) Execute production runs (flow scenarios) to understand and evaluate the hydraulics of current (existing) conditions and any changes to:

   a. Fishway attraction flows;

   b. Turbine operations; and

   c. Emergency spill and log sluice gates

4) Develop a series of velocity maps at select discharges. Relative to upstream passage, the CFD modeling will show approach velocities and flow fields that may create a response in fish;

5) The CFD modeling will be coupled with the telemetry study and passage counts to understand which conditions are preferable for guiding migrating fish to the entrances; and

6) With respect to downstream passage, the CFD modeling will provide information on velocities and flow fields in front of the powerhouse intakes. At Cabot, the goal is to obtain results that will indicate whether fish are directed to the surface bypass weir. At Station No. 1 the goal is to have a better understanding of velocity in front of the powerhouse intake.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study was requested by NHFGD, MDFW, NOAA NMFS, USFWS, CRWC, and TU. As outlined in their study request letters, the management goals of this study are:

"…to obtain information that will help assist in designing effective upstream fishways for upstream migrating trust species and to *reduce impingement, entrainment and delay for downstream migrating fish. CFD models are a relatively cost effective way to analyze existing and future conditions. As such, changes in the amount of attraction water, changes in which turbines are operating and which spillway gates are releasing water can all be examined. This study's results are intended to be analyzed in coordination with the data generated from the telemetry study. The combined analysis from these two data sources can help assess which flow conditions are most advantageous for migrating trust species to enter the fishway under current and proposed conditions.*

As for downstream migration of adult and juvenile shad, and adult eel, the results from the models will reveal flow magnitude and direction in front of each powerhouse. Given the limited information that currently exist on survival through Cabot and Station 1, the agency management goal is to direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream bypass. With respect to upstream passage, it is the goals of the agencies to maximize the number of fish that find and enter the fishway entrances.

Agency study requests are intended to facilitate the collection of information necessary to conduct effective analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.)."

[39] The spillway ladder entrance becomes inundated by flow from bascule gate no. 1 if there is any substantial spill over the dam, so the CFD model may have trouble effectively identifying some influences at such flows.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

As noted above, a CFD model of the Gatehouse fish ladder at the Turners Falls Dam is completed and can be found in Appendix F. Methodology defined and data collected during this effort will act as supplemental information for FirstLight's CFD modeling conducted as part of this study. FirstLight believes this recently completed model will be adequate for the required analysis and, as such, is not proposing to develop a new model for the Gatehouse fish ladder. However, additional model runs may be considered using the existing model, if necessary.

Existing GIS elevation data (i.e. contours, DEM, TIN) and Project drawings, combined with field collected data, will be used for the model input. In order to obtain the level of detail required of a three-dimensional model, a bathymetry survey of the study area will be conducted. Field data collected during this effort will include: river bed elevation, water surface elevation, water depth, and velocity (where field conditions allow). The model will be validated with field data prior to executing production runs.

Project Nexus (18 CFR § 5.11(d)(4))

The Turners Falls Project consists of two hydroelectric stations (Station No. 1 and Cabot Station), a power canal, bypass channel, dam and impoundment. In order to provide upstream fish passage through the bypass channel and power canal fish ladders were constructed at the Turners Falls Spillway, the Gatehouse at Turners Falls Dam, and at Cabot Station. A log sluice/bypass was constructed to provide downstream fish passage. Existing information indicates that substantial numbers of downmigrating fish use the log sluice/bypass. Due to a variety of hydraulic influences related to Project operations and/or naturally occurring hydraulic conditions, CFD modeling will be employed to evaluate potential fish passage barriers in the study area. Though the CFD results will provide insight to the hydraulic influences in the study areas, it is important to remember that other non-hydraulic factors can also factor into whether and how fish use a passage structure. This study will focus only on the hydraulic influences at the Spillway and Cabot Station fish ladders as related to fish passage effectiveness, as well as the Cabot and Station No. 1 influences relative to downstream fish passage effectiveness. The Gatehouse fish ladder will not be included in this study due to the fact that a CFD model was previously developed in 2011-2012.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

CFD models will be developed and various production runs will be executed to gain a better understanding of hydraulic conditions at the Cabot Station and Turners Falls Spillway fish ladders as well as the Station No. 1 and Cabot Station forebays. Prior to development of the models, bathymetric surveys will be conducted at the entrances of the fish ladders and the powerhouse forebays to collect the necessary model input data. In order to effectively meet the requirements of this study, four key tasks have been identified. These tasks include: 1) bathymetric survey of the study area; 2) compile model input datasets in CAD; 3) construct, calibrate, and validate the three-dimensional model; and 4) execute model production runs. These tasks are described in more detail below.

Task 1: Bathymetric Survey of the Study Area

Water surface elevations and water depths will be collected to create bathymetric map of the study area. Data will be collected throughout the study reach, including at the fish ladder entrances and in the forebays, along a number of evenly spaced transects and longitudinal profiles. Figure 3.3.8-1 shows the proposed modeling and data collection locations. Water column velocities will also be collected during this task.

Task 2: Compile Model Input Datasets in CAD

Utilizing existing ArcGIS elevation data and the bathymetry data collected in Task 1, three-dimensional surfaces of the study area river bed will be constructed in AutoCAD Civil 3D. Project drawings will then be used to develop three-dimensional representations of the fish ladders and pertinent Project facilities. Once completed, the three dimensional surfaces and Project facilities models will be compiled into one CAD file (per area) to depict a full physical representation of that area. The composite CAD files will then be used to create the input files for the CFD models.

Task 3: Construct Three-Dimensional Model

The input CAD files developed in Task 2 will be used to build four functional three-dimensional FLOW3D hydraulic models. Once built, various test scenarios will be run utilizing the field data collected in Task 1 to validate the model results. The model will be validated using field collected water surface elevations and water column velocity data.

Task 4: Execute Model Production Runs

Once the models have been satisfactorily calibrated and validated, production runs utilizing various input parameters will be developed and executed. The results of these model runs will provide a better understanding of the hydraulics at various flows and river conditions. FirstLight expects to run up to nine different "production run" flow scenarios as part of this study, not including the existing conditions run. These flow scenarios will be developed in consultation with the relicensing stakeholders.

Task 5. Report

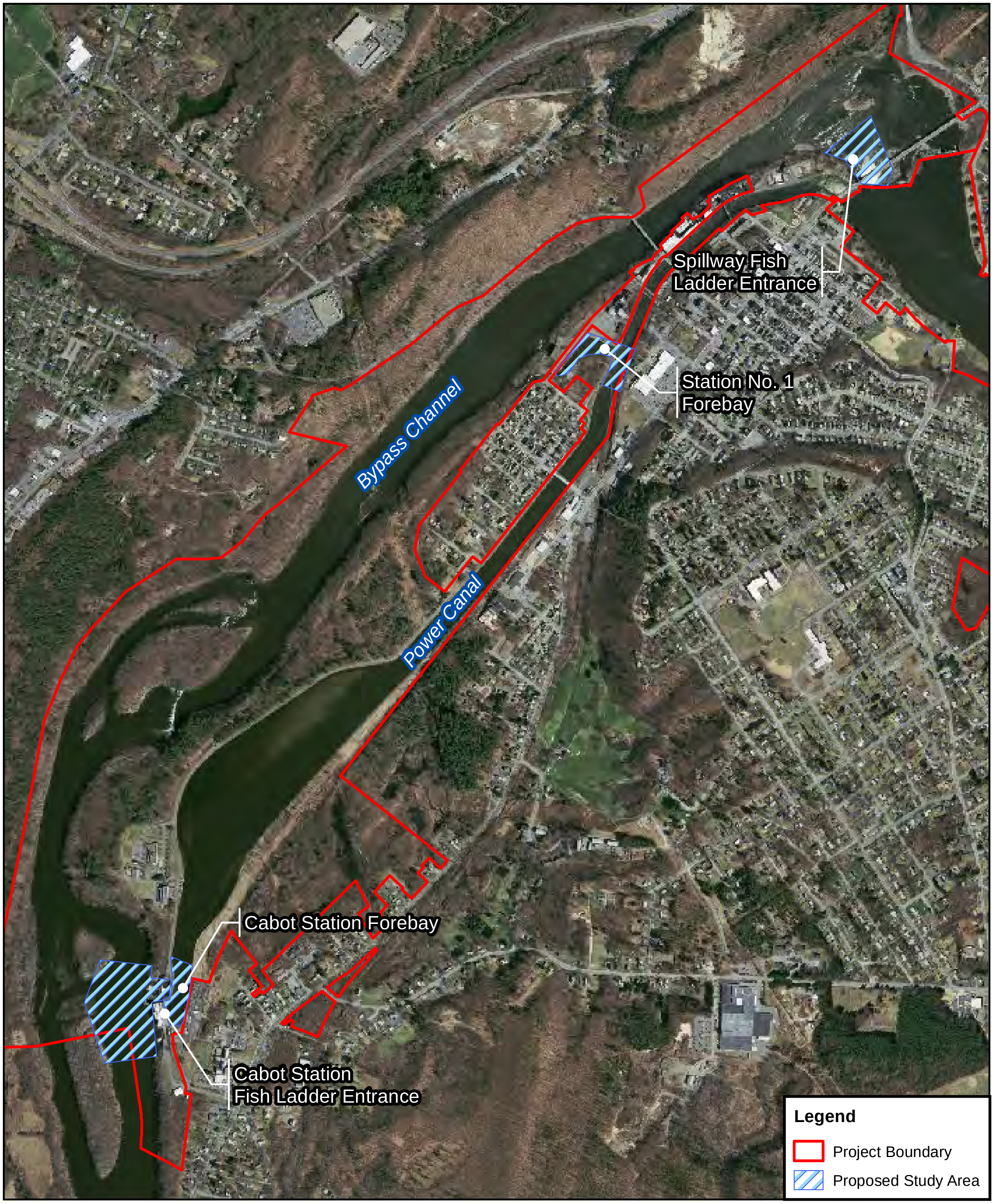
A report will be developed summarizing the findings of the study.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort defined above is adequate to conduct CFD modeling in the study area. Due to the location of the powerhouses and fish ladders along the power canal/bypass channel, four separate bathymetry surveys will need to be conducted and four separate CFD models will need to be developed (Spillway ladder entrance, Station No. 1 forebay, and Cabot ladder/forebay). As such, the total cost to conduct this study is approximately $200,000 to $300,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight proposes to conduct this study during the 2014 study year. The bathymetric survey, and any other pertinent field efforts, will be completed during the spring or early summer of 2014 contingent on safe river conditions. Assuming field efforts are completed by early June, data post processing and CAD model development will be completed by mid to late August. Once all model input data has been created, CFD model testing and production runs will occur throughout the fall 2014. All modeling efforts are intended to be complete by the end of the 2014 study year.



FirstLight Power Resources
GDF SUEZ

N

0 700 1,400 2,800 Feet

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Figure 3.3.8-1: CFD Modeling Locations in the Vicinity of the Turners Falls Power Canal and Bypass Channel

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3.3.9 Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace.

General Description of Proposed Study

The USFWS, NHFG, MDFW, CRWC, TU, LCCLC, and the Town of Gill requested similar studies utilizing CFD modeling in the vicinity of the Northfield Mountain Project intake/tailrace channel and in the Connecticut River upstream and downstream of the intake/tailrace to evaluate flow field conditions. The Northfield Mountain Project discharges water from its upper reservoir into the Connecticut River when generating and withdraws water from the Connecticut River to the upper reservoir when pumping. Pumping and generating associated with Project operations utilize the same infrastructure, at the same location (Figure 3.3.9-1). To better understand potential Project operations impacts, River2D software will be used to conduct two-dimensional modeling of the study area.

In 2007, Woodlot Alternatives developed a two-dimensional model of the Turners Falls Impoundment from Vernon Dam to Turners Falls Dam, including the majority of the proposed study reach. The 2007 Woodlot model was developed using 2006 bathymetry data collected by HydroTerra. A modified version of this model will be used to satisfy the objectives of this study. In order to modify the existing model, new supplemental bathymetry data will be collected in the vicinity of the Northfield tailrace and input into the model. FirstLight will collect the new supplemental bathymetry data as part of this study.

Once the model is updated, various model production runs will be conducted to analyze the hydraulic characteristics (depth, velocity) found in the study area over a range of conditions.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

Goals and objectives of this study are to:

- Model flow characteristics upstream and downstream of the Northfield Mountain Project under existing Project operations (pumping/generating), at several representative river flow levels, and at proposed changes to operations such as those discussed in Section 3.4.4 of the PAD;
- Assess velocities and flow fields at, and in proximity to, the Project intake/discharge structure, when pumping or generating, and their potential to interfere with fish migration;
- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the Project, alone or in combination with generation flows from the upstream Vernon Project;
- Assess the potential for Project operations to create undesirable attraction flows to the intake/discharge area that may result in entrainment or delay of migratory fish;
- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish; and
- Model and then evaluate flow characteristics under alternative Project operations. The alternative operation scenarios will be developed in consultation with the relicensing stakeholders after the initial study results are complete.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study was requested by MDFW, USFWS, NHFGD, Town of Gill, LCCLC, CRWC, and TU. The Town of Gill, LCCLC, CRWC, and TU are not resource agencies.

The MDFW, USFWS, and NHFGD all state that the goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for pumping cycles to confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Project operations data including pumping, generation, water surface elevation, and other pertinent information are currently collected and maintained by FirstLight.

In 2007 a two-dimensional flow model for the Turners Falls Impoundment, including the majority of the study area, was developed by Woodlot Alternatives. Although not originally developed to meet the scope of this proposed study, the data used to develop the original model, combined with updated data where needed, can be utilized to satisfy the goals and objectives previously discussed. As part of the 2007 modeling work, a bathymetric survey of the Turners Falls Impoundment, including the study area, was conducted in 2006 by HydroTerra. The bathymetry data collected as part of that survey, combined with proposed newly collected data in the vicinity of the Northfield tailrace, will be used to update the existing two-dimensional model where required.

Due to the extensive amount of existing information in the study area, FirstLight is not proposing to develop a new two-dimensional model or bathymetric survey. FirstLight instead proposes to review and update the existing model with supplemental field data collection as needed.

Project Nexus (18 CFR § 5.11(d)(4))

The Northfield Mountain Project discharges water during generation and withdraws water during pumping from a channel adjacent to the mainstem of the Connecticut River. Pumping and generating associated with Project operations utilize the same infrastructure, at the same location. Existing Project operations affect instream flows in this area. Potential impacts of Project operations may include: passage of migratory fish near the pump/discharge area, entrainment during pumping operations, and creation of flow reversals in the Connecticut River during pumping cycles which may confuse migratory fish attempting to pass the Project.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The 2007 Woodlot Alternatives two-dimensional model will be updated and various production runs will be executed to gain a better understanding of the potential impacts of Northfield Mountain Project operations within the study area. For the purpose of this effort, the study reach will include the Northfield Mountain Project intake/discharge channel and the Connecticut River 1 km upstream and downstream of the channel (Figure 3.3.9-1). In order to effectively meet the requirements of this study, four tasks have been identified, including: 1) review existing data and identify data gaps; 2) conduct a bathymetric survey of areas identified in Task 1, post process field collected, and post process model input data; 3) build and calibrate the two-dimensional model; and 4) conduct steady-state model runs using River2D software. These tasks are described in more detail below.

Task 1: Review Existing Data and Identify Data Gaps

Input bathymetric data used to create the original 2007 model will be reviewed for accuracy and completeness. All data gaps will be identified to ensure the entire study reach, including the intake/discharge channel, are accurately represented in the final model. Areas found to be lacking adequate bathymetric coverage will be supplemented with newly collected bathymetry data. Based on review of the existing data, FirstLight anticipates collecting supplemental data in the area of the Northfield tailrace at a minimum.

Task 2: Bathymetric Survey Update & Post Processing

As part of this study, new bathymetry data in the vicinity of the Northfield tailrace will be collected. Water surface elevations, water depths, and water column velocities will be collected along a number of evenly spaced transects and longitudinal profiles.

Task 3: Build and Calibrate 2D Model

The original model input files and the additional field collected data will be merged into one dataset to build a functional two-dimensional model using River2D software. River2D is a depth-averaged two-dimensional (lateral-longitudinal) finite element hydraulic and habitat model. It requires input data for a set of spatially-distributed points or “nodes” throughout the study reach. It then creates a linearly-interpolated triangulated mesh from the set of nodes, with each triangle referred to as an “element.” River2D solves for mass conservation and momentum balance in two (x,y) dimensions using the St. Venant flow equations. Input data include a digital bathymetric (riverbed topography) map, a stage-discharge relationship or boundary elevation at the downstream end of the study reach, and bed roughnesses throughout the study reach. Observed water surface elevation data are used for calibration purposes, but are not direct model inputs.

The model will be built to ensure an accurate representation of the river bed’s physical features. Steps in building the model will include importing the bed elevation or “node” data, and then building a finite-element computational mesh consisting of linear triangular elements. An initial uniform gridded base mesh will be generated on an approximately 50-75 ft spacing, though the actual base mesh density will depend on how rapidly bed features change and on computational limitations. The mesh will then be modified with the primary objective of accurately representing the river bed structure within the model. This will be done by visually assessing the raw bathymetry data, aerial photos and using local knowledge of the river to identify areas of potentially complex flow. At each node, bed elevation and roughness height will be specified.

Once built, the model will be calibrated to existing water surface elevation data. Calibration will be an iterative process that will primarily consist of adjusting the nodes’ “roughness coefficient” within the model to better fit observed water surface elevations and water velocities. For example, if model-predicted water surfaces are higher than observed data show, then surface roughnesses may be lowered. If model-predicted water surfaces are lower than observed data show, then surface roughnesses may be raised. Surface roughnesses, given the units of length, must be kept within reasonable limits given the bed makeup, and is typically not larger than 1-3 times the maximum particle size (D100) within that area, unless there is a large amount of non-bed debris or other atypical features. Calibration may also involve adjustments to the finite element mesh to increase node density in complex flow areas not identified in the initial mesh construction. Successful calibration will yield results within ±0.15 ft of field-measured water surface elevations for at least one calibration scenario, as well as a reasonable match with field-collected velocity profiles.

Task 4: Conduct and Analyze Production Runs

Once the model has been calibrated, production runs representing various operating scenarios will be run. The runs will reflect steady-state hydraulic conditions. The model run results will include two-dimensional water depths and velocities. These outputs can be used to provide a better understanding of potential fish passage barriers resulting from Project operations at various flows, river conditions, and other hydraulic influences.

Task 5: Report

A report will be developed summarizing the findings of the study.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort defined above is adequate to conduct River2D modeling in the study area. The results of the River2D model production runs will provide the data necessary to satisfy the goals and objectives previously outlined. The estimated cost for this study is approximately $40,000 to $50,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight will conduct this study during the 2014 study year. Existing data will be reviewed for accuracy and completeness and data gaps will be identified during the late winter, early spring of 2014. All field efforts required to update the existing bathymetry and model input data will be conducted in the spring or early summer provided there is an adequate amount of flow present in the study reach. Assuming field efforts are completed by early June, data post processing will be completed by mid August. Once all model input data has been created, the two-dimensional model will be calibrated and production runs will be executed throughout the fall 2014. All modeling efforts will be completed by the end of the 2014 study year.

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PROPOSED STUDY PLAN

Figure 3.3.9-1: Two-Dimensional Modeling at Northfield Mountain Intake/Tailrace

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3.3.10 Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

General Description of Proposed Study

MADFW requested a study investigating the impacts of Project operations on the emergence of riverine odonates, with an emphasis on state-listed species. MADFW requested that these studies be conducted in the upper reservoir, the Turners Falls Impoundment, and a 13-mile reach from the Turners Falls Dam to the Route 116 Bridge in Sunderland. FirstLight is limiting the study area to the Turners Falls Impoundment and 13-mile reach below the Turners Falls Dam. The near-complete lack of a shallow vegetated littoral zone and rocky substrate in the upper reservoir, together with its characteristic water level fluctuations, would likely preclude state-listed odonates (particularly riverine species, which are the focus of this study). The study will include synthesis of existing data, field surveys, and the use of a hydraulic model (see Section 3.2.2) to assess potential effects of water level fluctuations on factors related to odonate emergence/eclosure behavior.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

This study has two objectives:

- Synthesis of existing data, supplemented with field surveys, to characterize the assemblage structure and emergence/eclosure behavior of odonates in the project area.
- Determine if project operations affect the emergence and eclosure success of state-listed odonates, and the potential implications for the odonate assemblage in affected areas, particularly state-listed species.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The Massachusetts Natural Heritage & Endangered Species Program (NHESP), part of the MADFW, is charged with ensuring the conservation and protection of species listed under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) as Endangered, Threatened, or of Special Concern. The resource management goals identified by the NHESP/MADFW are to:

- Ensure that PME measures are commensurate with Project effects and meet MESA requirements for the Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations.

The MADFW study request is intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, PME measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the Massachusetts Wetlands Protection Act (WPA).

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

State-listed Odonate Species Composition: The status of state-listed odonate species is well documented for the Turners Falls Impoundment due to several studies conducted 2001–2010 (Morrison et al., 2001; 2004; 2006; Mclain et al., 2004; 2006; Martin, 2007; 2010). Six state-listed species have been observed within reaches above the dam—Cobra Clubtail (*Gomphus vastus*), Stygian Shadowdragon (*Neurocordulia yamaskanensis*), Spine-crowned Clubtail (*G. abbreviatus*), Skillet Clubtail (*G. ventricosus*), Riverine Clubtail (*S. amnicola*), and Midland Clubtail (*G. fraternus*) (McLain et al., 2006). Cobra Clubtail and Stygian Clubtail are the most abundant state-listed species encountered in this area. In contrast to the Turners Falls Impoundment, survey effort below the dam has been far less intensive; this region of the Connecticut River represents an information gap with regard to rare odonate species composition and abundance.

Based on odonate studies conducted in the Turners Falls Impoundment, as well as both published and unpublished research on the life history and ecology of these species, we have a basic understanding of emergence and eclosure, including when emergence occurs, how high above the water eclosure takes place, how long the process takes, what substrates are typically used, and how these factors differ by species or family groups. To some extent, a thorough review of existing information will provide adequate biological information for an impact assessment using the hydraulic model (see Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot Station*), but field observations are planned to fill critical knowledge gaps by conducting surveys in both the Turners Falls Impoundment and downstream from the Turners Falls Dam. For example, because much of the odonate research in the Turners Falls Impoundment was initiated due to riverbank stabilization efforts, some habitat types (e.g., the lentic environment near Barton's Cove) have not been well surveyed for odonates, and the emergence/eclosure behavior of odonates in these different habitat types is not well understood.

Impact of Water Level Fluctuations: The extent to which water level fluctuations disrupt odonate emergence and eclosure is not well understood. The concern is whether emergent larvae ascend a great enough vertical distance, and quickly enough, to avoid being inundated after eclosure begins. This will depend on a variety of factors, such as the propensity of a species to travel far or climb high, the timing of emergence compared to the timing of water level fluctuations at that particular site, bank slope, and substrate. Related research in the Connecticut River by Martin (2010) and others (McLain et al., 2004, 2006; Morrison et al., 2001) has investigated the factors that influence the distance nymphs travel before eclosure; air temperature, substrate, and water velocity were among factors identified. Studies have found that coarse substrate on the riverbank, especially riprap, discouraged travel of some odonate nymphs. The furthest nymphs were recorded traveling during these studies on any substrate is about 40 feet (Martin, 2010), but many eclose after traveling just a few feet.

The effect of water level fluctuations on aquatic habitat parameters in the Turners Falls Impoundment and downstream from the Turners Falls Dam is not well documented. A separate study plan is proposed to produce a hydraulic model of these areas (see Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot Station*).

Project Nexus (18 CFR § 5.11(d)(4))

The timing, rate, and magnitude of releases from the Projects may have adverse effects on state-listed riverine odonate tenerals (newly emerged) although the degree of these effects is unknown. In order to fill this information gap, an empirical study is proposed to provide information on the relationship between Project operation and the effects of water level changes on emerging odonate tenerals. Results will be used by the MADFW to determine appropriate recommendations to protect and/or enhance state-listed odonates and their habitats.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Review of Existing Information

Existing information on the species composition of odonates in the proposed study reach of the Connecticut River will be gathered from a variety of sources (see Literature Cited in this section). The life history and ecology of these species and species groups will be summarized, and significant data gaps related to habitat preference and emergence/eclosure behavior will be identified.

Task 2: Finalize Study Plan and Attain Collection Permit

Because the study is focusing on state-listed odonate species, FirstLight will work with NHESP to finalize the study plan and attain the necessary permit to handle/collect state-listed odonates. FirstLight will comply with the conditions and reporting requirements of the collection permit.

Task 3: Qualitative Surveys for Larvae and Exuviae

Odonate larvae and exuviae will be surveyed between the Turners Falls Dam and the Route 116 Bridge in Sunderland, and in the Turners Falls Impoundment near Barton's Cove, to establish a qualitative baseline for the odonate assemblage in these areas (Figure 3.3.10-1). Aside from the Barton's Cove area, surveys above the Turners Falls Dam are not necessary due to the intensive survey effort in this area from 2001 to 2010. The survey will be conducted just prior to spring emergence (late May to early June) to maximize detection of all species, under conditions of average to below-average river flows. Representative shoreline habitats in Barton's Cove, totaling approximately 200 meters, will be surveyed. Three representative 200-meter reaches will be surveyed downstream from the Turners Falls Dam: one study reach will be located near the confluence of the Connecticut River and the Deerfield River, one will be just upriver of the Route 116 Bridge, and one will be at a location in between (to be determined). Collection methods will include aquatic D-nets or other nets appropriate for conditions at each site, as well as collection of tenerals or exuviae on the riverbank (if emergence has started). Collections will be made while wading or snorkeling in shallow water, SCUBA diving in deep water, or while walking along the riverbank. At each site, aquatic, riparian, and upland habitats will be photographed and the following parameters will be recorded.

Aquatic Parameters: water depth, water velocity, dominant substrate types, species composition and coverage of aquatic plants, presence and coverage of fine and coarse organic material;

Riparian Parameters: bank slope, bank height, bank stability, dominant substrate types, plant species composition and cover, tree canopy height, tree canopy density;

Upland Parameters: land use/land cover, dominant vegetation.

Task 4: Quantitative Surveys of Emergence/Eclosure Behavior

Quantitative surveys to determine the emergence/eclosure of odonate species will be conducted at four study reaches. Through consultation with NHESP, two study reaches will be selected from the Turners Falls Impoundment and two will be selected from downstream of the Turners Falls Dam. The specific reaches will be selected to represent a range of aquatic and riverbank habitat conditions and hydraulic characteristics. The two reaches selected in the impoundment will have different habitat than the sites associated with riverbank stabilization that were monitored from 2001 to 2010.

Six transects will be established within each study reach, for a total of 24 transects. Transects will be monumented with PVC pipe or rebar along their length. Each transect will be perpendicular to the river, 1 m wide, and will extend upslope approximately 12 m (i.e., the greatest distance recorded in earlier studies of odonate emergence in this area). The following habitat data will be collected at each transect: GPS location of both ends, slope, elevation of the upslope and water ends, elevation of the mean high water mark, types and percent cover of each substrate type, substrate embeddedness, species composition and percent cover of aquatic and upland plants, and anything else noteworthy about conditions at each transect. All transects will be photo-documented. In addition to these transect-specific data, aquatic, riparian, and upland habitat will be characterized for each of the four reaches, as described under Task 3.

Surveys for emerging larvae, exuviae, and tenerals will be conducted at each transect every two weeks from June through August, and will be timed to coincide with weather and flow conditions that are conducive to emergence, and during times that are generally considered peak emergence periods for odonates that occur in these areas. The time of day, weather, water level, and a qualitative assessment of boat traffic will be recorded at the time of each survey. For each exuvia and teneral found, the emergence distance from the water, elevation, and the structure/substrate it was found upon will be recorded. All exuviae will be collected in individual vials, labeled with site information and date, and preserved for later species identification. If possible, emerging larvae will be watched/tracked as they progress upslope, and the time it takes for them to stop and eclose will be recorded.

Water level data will be used to identify the zones along each transect that have low, moderate, to high inundation frequency. The abundance, density, and species composition of emerged odonates will be compared along a gradient of inundation frequency (taken from water level data). In addition, the influence of water level, habitat characteristics (substrate, vegetation cover, elevation), and weather conditions on emergence distance will be determined using correlation and regression analyses.

<u>Task 5: Water Fluctuation Impact Assessment</u>

A hydraulic model, which will be developed for the whole study area independent of the odonate study, will be used to determine if water level fluctuations affect the emergence and eclosure success of state-listed odonates. The field data gathered during Task 4, particularly the timing (e.g., when species emerge), distance travelled (both horizontal and vertical), and duration (i.e., speed) of travel and eclosure for species and/or species groups will be used in concert with the hydraulic model to determine which species are most vulnerable to fluctuating water levels, and under what conditions they are most susceptible.

<u>Task 6: Report</u>

A report will be prepared describing the survey and modeling methods and results. A tentative table of contents follows:

- Introduction
- Study Area
- Methods
  - Larval Surveys
  - Exuvia Surveys
  - Water Level Impact Assessment
- Results
  - Larval Surveys
  - Exuvia Surveys
  - Water Level Impact Assessment

- Discussion
- Conclusions
- Literature Cited

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The methods and analyses proposed are consistent with other studies of this nature, and build upon knowledge gained from other studies to focus specifically on the effects of water level fluctuations. The estimated cost for this study may range from $40,000 - $60,000 (not including the hydraulic modeling completed as a separate study). Task 3, which can be considered a first phase of fieldwork that would inform the quantitative surveys, would cost in the range of $8,000 - $10,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Field work for this study is proposed to occur in 2014. A final study plan for the quantitative survey and hydraulic/habitat analysis would be developed in cooperation with NHESP.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

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Martin, K. (2008). Impact of bank stabilization technique, boat wake, water level rise, and predation on the mortality rate, and eclosure success of odonate nymphs in Gill, MA: Results of the 2008 field season. Unpublished report (New England Environmental, Inc.)

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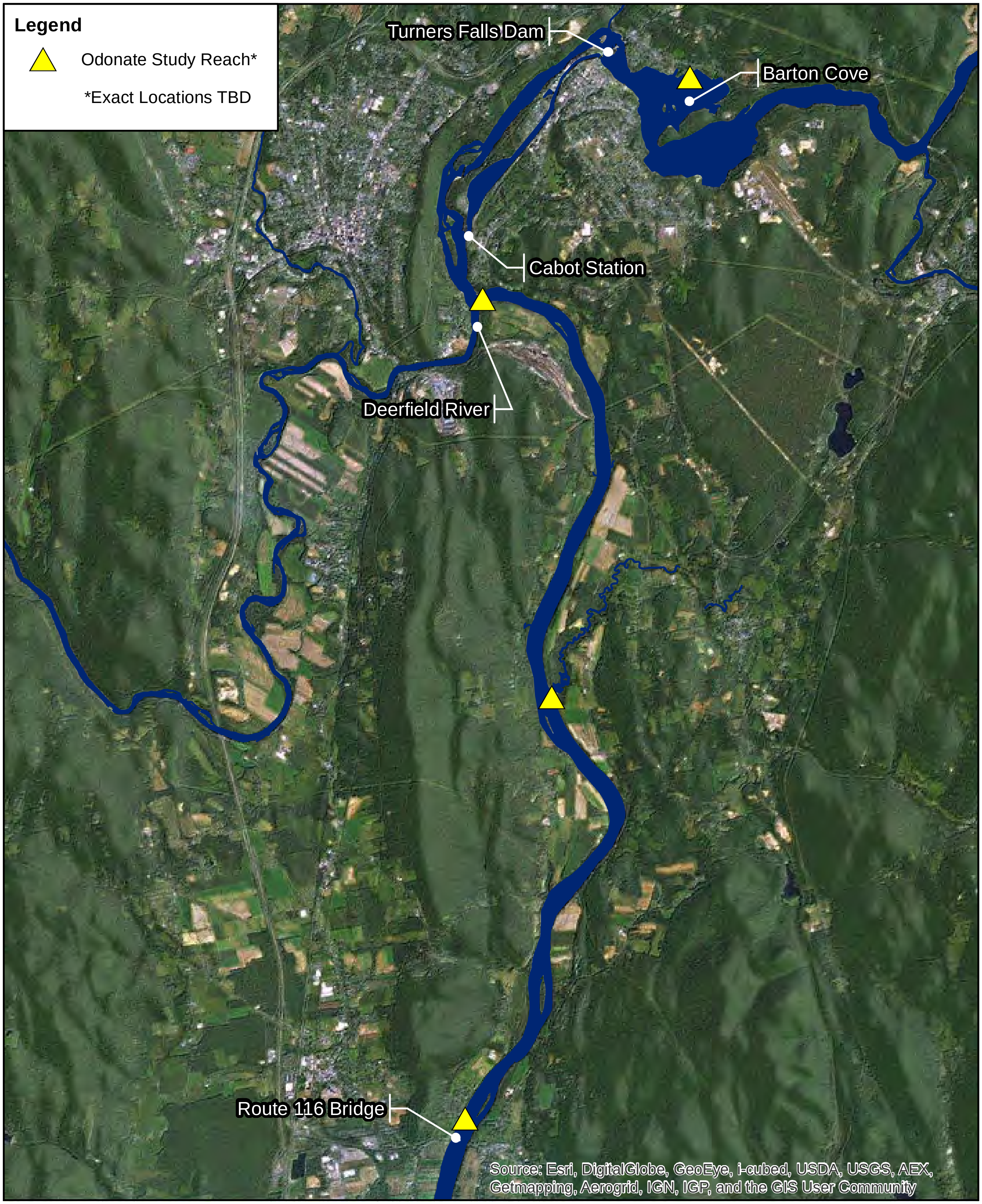

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Proposed Study Plan

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Figure 3.3.10-1: Approximate Reach Locations for Odonate Surveys.

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3.3.11 Fish Assemblage Assessment

General Description of Proposed Study

In the study request letter from the FERC, a baseline fisheries population study was requested. The request included sampling within the Turners Falls Impoundment, tailwater areas, the bypassed reach, and downstream riverine corridors via electrofishing surveys. The FERC also requested targeted eel sampling of upstream and downstream migrating American eel. Targeted eel sampling will be conducted as part of Study No. 3.3.4 – *Evaluate Upstream Passage of American Eel at the Turners Falls Project* and silver-phase eel abundance and migration will be evaluated in Study No. 3.3.5– *Evaluate Downstream Passage of Eel*; thus, additional targeted eel sampling is not being proposed for this study.

In their study request letters, USFWS, MADFW, NHFGD, CRWC, Town of Gill, TNC, TU, VANR each requested a fish assemblage assessment to determine the occurrence, distribution, and relative abundance of fish species within the project areas and to compare study results to historical records. They requested a comprehensive assessment of fish assemblages, employing multiple gear types to randomly sample a variety of habitats throughout the study area during spring, summer, and fall as part of a robust sampling design. The proposed study will include a statistically rigorous and comprehensive stratified-random design similar to what has been used successfully on large rivers a high degree of spatial heterogeneity.

MADFW further requested that the study include state-listed fish species as well as host fish species of the dwarf wedgemussel (*Alasmidonta heterodon*), federally- and state-listed as “Endangered”; the yellow lampmussel (*Lampsilis cariosa)* state-listed as “Endangered”; and the Eastern pondmussel (*Ligumia nasuta*), state-listed as “Special Concern.” MADFW requested that the study should assess the occurrence and abundance of mussel larvae on resident host fish. FirstLight is not proposing to evaluate mussel larvae on host fish because the relationships are already well understood (Table 3.3.11-1); the level of effort proposed will provide data on the distribution and relative abundance of state-listed fish species and host fish species.

The PAD for the Turners Falls Project and Northfield Mountain Projects identifies 22 species of fish that occur in the aquatic habitat within the Project boundary. The study described herein will document fish species occurrence, distribution and relative abundance within the Turners Falls Project and Northfield Mountain Project areas. FirstLight believes that the level of effort will provide baseline fish assemblage data and that the overall sampling design will provide useful data that can be used to inform other proposed studies.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to provide baseline information pertaining to the fish assemblage structure within the study area. Specific objectives include to:

- Document species occurrence, distribution, and relative abundance of resident and diadromous fish within the project area along spatial and temporal gradients.
- Describe the distribution of resident and diadromous fish species within reaches of the river and in relationship to habitat.
- Compare historical records of fish species occurrence in the project area to results of this study.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The MADFW, NHFGD and the VTFWD each have, as a mission, the protection and conservation of fish and their habitats. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' Species of Greatest Conservation Need (SGCN) have been documented in the project area.

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the MADFW. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The Division seeks to accomplish the resource goals and regulatory requirements of the MESA in order to:

- Ensure that PME measures are commensurate with Turners Falls Project and Northfield Mountain Project affects and meet MESA requirements for the Turners Falls Projects and Northfield Mountain Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Turners Falls Project and Northfield Mountain Project operations.

The agencies requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, PME measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA. Specific to state-listed fish and mussel species, the Divisions goals are to:

- Protect, enhance, or restore diverse high quality aquatic habitats in the Connecticut River watershed and mitigate for the loss or degradation of these habitats.
- Minimize current and potentially negative effects of Turners Falls Project and Northfield Mountain Project operations on state-listed species and their habitats.

Determining species occurrence, distribution, and abundance of fish species will better clarify what species occur in the project area both spatially and temporally relative to habitats which may be affected by operation of the Turners Falls Project and Northfield Mountain Project. This information will better inform results from other study requests that will be examining the effects of operations of the Turners Falls Project and Northfield Mountain Project on various aquatic habitats, water quality, and other related concerns such as entrainment concerns at the Northfield Mountain Project. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project area and impacts that may affect their population status through direct or indirect effects of the Turners Falls Project and Northfield Mountain Project.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

A study of resident fish species in the Turners Falls Impoundment was conducted by the Commonwealth of Massachusetts from 1971 to 1975. Eight stations in the impoundment were sampled every other week from April through October with electrofishing equipment (MDF&G, 1978). Because many changes have occurred throughout the watershed during the last four decades, these data may not be an accurate representation of the current fish assemblage.

In 2008 the impoundment was surveyed via electrofishing; this survey, conducted by Midwest Biodiversity Institute (MBI), was part of a larger USEPA effort to sample the entire Connecticut River from its headwaters at Lake Francis to the freshwater extent of the tidal estuary (Yoder et al., 2009). The 2008 survey did not have the same goals and objectives as this study; thus, data collected is not sufficient to assess the abundance, occurrence, or distribution of fish within the study area or in relation to project operations. Neither study employed the use of alternative gear types; while electrofishing is considered to an effective method for capturing fish in littoral areas of flowing water, capture probabilities are typically lower for small fish or those lacking swim bladders. It is also not effective at capturing fish from deep water unless modified. A total of 22 fish species was identified in the project area based on historical data, but several species reported to occur within the project area were not documented, including Northern pike, burbot, Eastern silvery minnow, and channel catfish.

As referenced in the PAD, Section 4.4, two state-listed fish species are known to occur in the Connecticut River, including the Eastern silvery minnow (*Hybognathus regius*) and burbot (*Lota lota*), both of which are state-listed as "Special Concern." Currently, there are only two known populations of the Eastern silvery minnow in Massachusetts, both located in the Connecticut River. Burbot are also rare in Massachusetts, with only a few individuals having been collected in the Connecticut River watershed.

The tessellated darter is one of only three fish species in the Upper Connecticut River that serve as hosts for the glochidia of dwarf wedgemussel, the others being the slimy sculpin (*Cottus cognatus*) and the Atlantic salmon (*Salmo salar*) (Nedeau, 2008). Tessellated darters are a relatively sedentary benthic insectivorous fish with small home ranges and short, fast bursts of speed.

Based on data collected by Yoder (2009), sampling at 4-5 transects distributed throughout the Turners Falls Impoundment was sufficient to capture most but not all species detectable by electrofishing the shoreline of the impoundment (Figure 3.3.11-1); a closer inspection via rarefaction of individual transects surveyed indicates that the number of fish captured at some transects may not have been high enough to document most species within a reach (Figure 3.3.11-2). Based on the rarefaction curves from all transects electrofished, a minimum of 150 fish per reach would ensure that most species within a reach were captured, but four out of the five transects electrofished contained a sample of less than 150 fish (N = 9-75), with only one containing a sample greater than 150 fish (N = 580).

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and Northfield Mountain Project has the potential to directly affect fish populations, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater spawning areas, which could limit the productivity of certain fish species through direct impacts to their spawning success, ultimately resulting in alterations to fish assemblage structure. An understanding of the current fish assemblage is needed in order to examine potential effects. Determining species distribution and abundance will clarify what species occur in the Turners Falls Project and Northfield Mountain Project areas, spatially and temporally, relative to habitats that may be affected.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The study area includes the Connecticut River from Vernon Dam to the Route 116 Bridge in Sunderland, although the geographic scope of this study is being reviewed by NMFS as the potential impact on shortnose sturgeon due to fish sampling may result in modifying the geographic area. The study area will be divided into stations based on habitat type; multiple methods of fish capture will be used in each station. Selected locations within each station will be sampled either by boat electrofishing (shoreline and littoral habitat), gill nets (deeper, benthic areas), and seine net (wadeable shoreline and littoral habitat) during the early summer and again in the fall. At least 18 stations will be sampled during each sampling event. Early summer sampling will be performed when spawning anadromous species are present; fall sampling will be performed when most juvenile fish are large enough to sample.

Task 1: Sampling Location Selection

Prior to field sampling, stations to be sampled will be selected to ensure all habitat types are adequately represented. Alternative sampling locations will also be identified by habitat in case a selected sampling station is inaccessible.

Task 2: Fish Capture

FirstLight anticipates using a variety of techniques to sample the various habitat types within the study area, including electrofishing, gill netting, and seining as described below. The type of gear utilized will be dictated by site conditions, in particular depth and access.

Boat electrofishing will be conducted along selected 500-meter transects within each sampling station. Boat electrofishing can effectively sample fish from most near-shore littoral habitats present within the Connecticut River (typically 10 feet deep or less). If fewer than 150 fish are collected within a station, additional transects will be electrofished at that station until a 150 fish sample is exceeded. This will ensure that most species within a station that are detectable by electrofishing are captured; because areas with low fish density require less time to sample than areas with high fish density, additional sampling due to low densities of fish encountered is not expected to increase the level of field effort by personnel, and the randomized selection of additional sites will improve precision without adding bias.

Electrofishing will be accomplished with the use of a 16-ft jonboat rigged with a pulsed-DC Smith-Root GPP 5.0 electrofisher with the capacity to adjust the pulse rates between 30 - 120 pulses/second and vary voltage to accommodate ambient conductivity. The electrode array includes a gang of cathodes suspended from the bow to a depth of approximately six feet to project the electric field into both the shoreline epibenthic zone, as well as the upper water column. The anode array is suspended from the bow on an adjustable boom. Both anodes and cathodes will be configured to optimize the electric field under ambient low conductivity conditions. A smaller vessel capable of negotiating riffles and shoals, similarly rigged with a 2.5 GPP unit may be deployed for sampling in the shallower riverine habitats. This smaller boat will consist of a 14 ft inflatable Sea-Eagle raft with retractable anodes and side-mounted cathodes.

Electrofishing will be conducted in a linear, downstream manner, following standardized methods developed specifically for large river quantitative electrofishing surveys (MBI, 2002, Yoder and Kulik, 2003). Boat electrofishing effort will be standardized by distance (km) and time (s) of sampling at each site. The start point, end point, and boat track for each sampling station will be geo-referenced using a handheld Garmin Map 76 GPS (or similar device) and transposed to corresponding USGS topographic mapping software program (Terrain Navigator).

All stunned fish will be collected with ¼-inch mesh dip nets and deposited into a live-well filled with aerated ambient river water. At the conclusion of each sample, all captured fish will be identified to species, classified as adult, juvenile or Young-of-Year (YOY), enumerated, weighed, measured for total length, and then released. If large numbers (n > 25) of small fish (YOY fish or cyprinids less than 100 mm) are captured, they will be grouped by size class, enumerated, and batch-weighed with length measurements only taken from one large and one small representative specimen within each group. Fish that are not able to be identified in the field, such as small cyprinids, will be brought back to the lab for identification.

For sampling deeper habitats where electrofishing will not be effective, sampling will be conducted with experimental gill nets. The 12-foot high gill nets 100-foot in length will be constructed of 4 to 5 panels of increasing mesh size (e.g., 1.5, 2, 2.5, 3, 3.5-inch stretched mesh) to accommodate collection of the various sized fish in the project waters. The nets will be deployed to maximize capture area where water depths are greater than net height. Nets will be set in selected locations and allowed to fish for 24 hours prior to retrieval. The exact locations of each net set will be recorded using a handheld Garmin Map 76 GPS (or similar device) and the time of deployment and retrieval will also be recorded. Fish processing will occur as described above for electrofishing.

In shallow shoreline locations where boat access may not be feasible, sampling will be performed via seining with a 100-ft long, 6-ft deep, 1/4-inch mesh bag seine net. Seine samples will be collected by extending the net parallel to shore and then pulling the upstream end of the net into the water and in a downstream direction for a 180 degree sweep while the opposite end of the net is held in place. The start point and end point for each sweep will be geo-referenced using a handheld Garmin Map 76 GPS (or similar device) and transposed to corresponding USGS topographic mapping software program (Terrain Navigator). Total fish catch will be processed following each tow in the same manner as described above for electrofishing and gill netting.

In addition to biological data, supporting data will also be collected for each sample site including; location (GPS), sampling gear type, sampling effort (soak time and/or seconds fished), mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, predominant substrate, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets. Upon return from the field, data sheets will be review for quality assurance and archived.

Task 3: Data Analysis and Reporting

Catch per unit effort (CPUE) and standard errors will be calculated for each species, station, and sampling technique. Data will also be separated into groups by size and a CPUE per size group will be calculated. Values of CPUE for each segment and gear type will be calculated as the sum of catch from all samples within a station divided by the sum effort expended within that station. The Shannon-Weiner index of diversity, which is a function of species richness and evenness, will also be calculated.

Information collected during this study will be compiled and presented in a final report. The report will include a map of the study area and will depict the location of sample sites and contain results for fish species occurrence, distribution and relative abundance. Comparisons will be made with historical records. Results will be described in relation to studies described in study plans 3.3.14 – *Aquatic Habitat Mapping of the Turners Falls Impoundment* and 3.3.13 – *Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat*.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort will adequately address the objectives by documenting fish species occurrence, distribution and abundance within the project area along spatial and temporal gradients. FirstLight estimates the cost of this study to be $75,000 to $85,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The study described herein is scheduled to be conducted in the early summer and fall of 2014, with Task 1 occurring prior to field studies.

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Table 3.3.11-1: Freshwater mussel and glochicial host fish relationships.

Freshwater Mussel	**Connecticut River Glochidial Host Fish**
Dwarf Wedgemussel	Tessellated darter, slimy sculpin, juvenile and parr Atlantic salmon
Yellow Lampmussel	White perch, yellow perch; banded killifish, chain pickerel, white sucker, smallmouth bass, and largemouth bass
Eastern Pondmussel	Unknown; reported to parasitize centrarchids (sunfishes and bass) as well as banded killifish

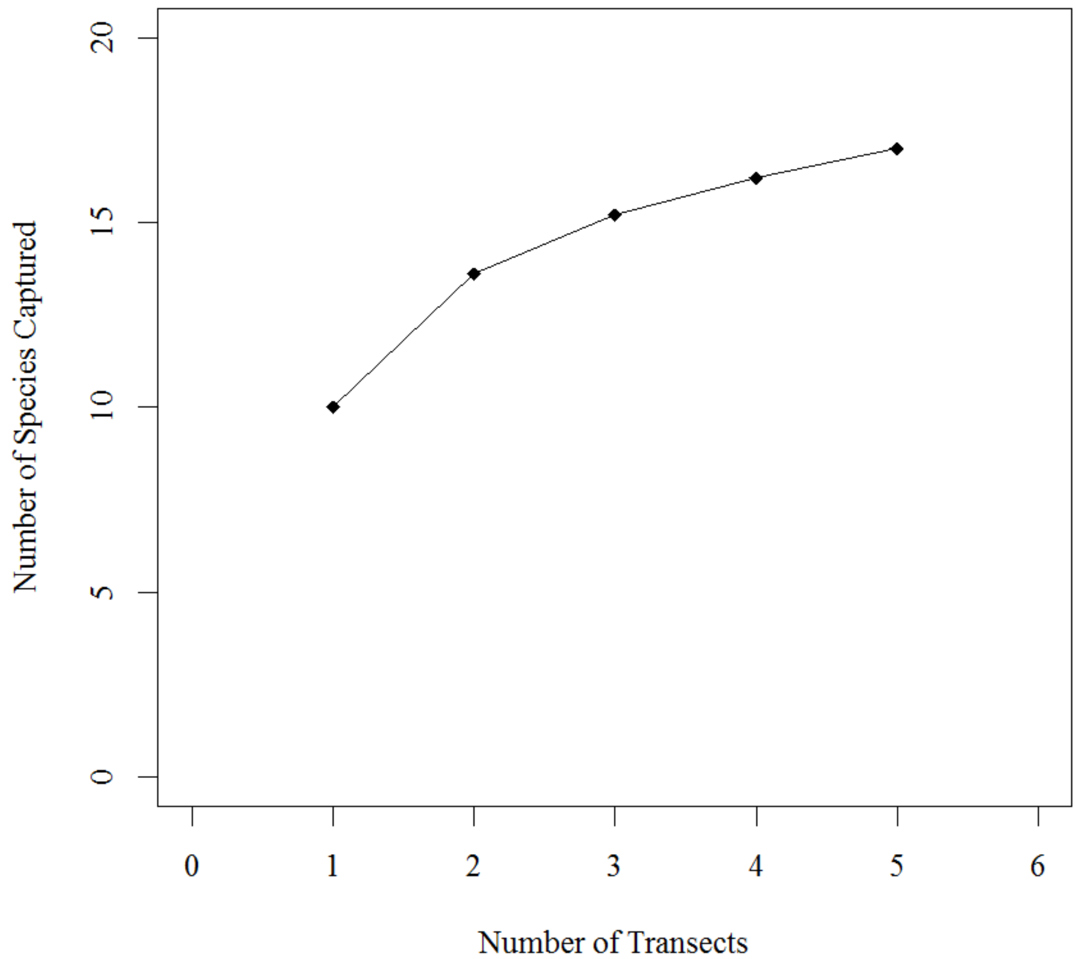

Figure 3.3.11-1: Species-accumulation curve derived from Yoder (2009) boat electrofishing data within the Turners Falls Impoundment

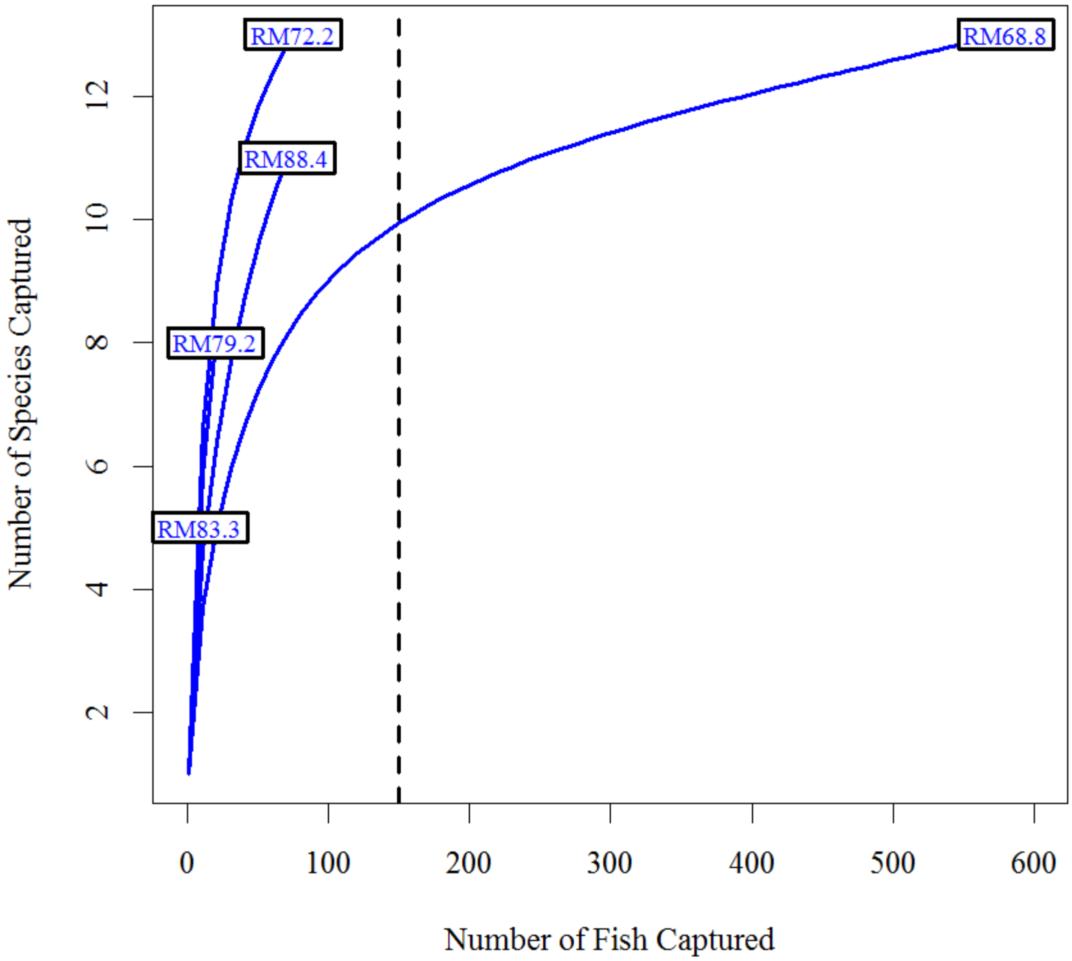

Figure 3.3.11-2: Rarefaction curves derived from each transect sampled by Yoder (2009). Labels indicate locations (River Mile) within the Turners Falls Impoundment where fish were sampled. The dashed vertical line indicates the proposed minimum sample size (n = 150 fish) per reach sampled.

3.3.12 Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

General Description of Proposed Study

In their study request letters, the USFWS, NMFS, NHFGD, and CRWC each requested a study to assess the impact of sediment disturbance and excessive velocities resulting from emergency water control gate discharge and bypass flume spill events on shortnose sturgeon spawning and incubation habitat in the Cabot Station tailrace and downstream areas.

Based on discussions held at the Proposed Study Plan Meeting on May 21, 2013, FirstLight is proposing to conduct this study incrementally. First, existing data will be obtained and analyzed to understand the operation of the emergency spill gates and bypass flume; second, this analysis will be shared with the resource agencies and a meeting will be held to discuss the results and to determine if a field component of the study is necessary; if so, field measurements will be collected in accordance with the methods detailed in this plan, subject to modification based on agency consultation. The field assessment will involve collecting information on water velocity and sediment transport conditions during spillage events at Cabot Station to describe potential impacts on shortnose sturgeon and to inform potential mitigation.

The Study Schedule section below identifies an estimated time line of activities to incorporate a consultation process into this study.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine the frequency of spill events during the sturgeon spawning duration, and, if deemed necessary, determine appropriate protocols for operation of the emergency water control gates and bypass flume that will be sufficiently protective of shortnose spawning and rearing below Cabot Station from excessive water velocities and exposure to abrasive sediments dislodged and transported across spawning and rearing areas.

The objectives of the study are to:

1. Determine the frequency that the emergency water control gates are operated to discharge large quantities of water.

2. Understand the operation of the bypass flume that results in bypass flume spill events.

3. Evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot Station.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The USFWS and NMFS seek to understand current emergency water control gate and bypass flume operations and associated impacts to determine potential operation protocols that avoid or minimize negative effects on shortnose sturgeon spawning and rearing.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

During monitoring of shortnose sturgeon spawning, researchers at the S.O. Conte Anadromous Fish Research Center [Conte Lab] have observed spillage at the emergency water control gate and the bypass flume that increased velocity over the rearing area downstream of Cabot Station and may have also resulted in a debris plume (Kieffer and Kynard, 2007; Kynard et al., 2012). The frequency of these events has not been studied, nor has the impact on shortnose sturgeon spawning and early life-history stages.

Ten gates are present at the Cabot spillway, two of which are used for attraction flow at the Cabot Fishway. The discharge capacity of these gates is 12,000 cfs at the normal canal level of 173.5'. The Cabot spill gates open automatically if the forebay water surface elevation exceeds a pre-set limit to prevent overtopping of the power canal walls. The gates will also open if changes in elevation indicate that a canal breach may have occurred. Operators open one or more gates when necessary to help remove debris from the trash boom.

The bypass flume is utilized as a downstream fish passage facility at Cabot Station and is generally open for fish passage from April through mid-November in accordance with a schedule provided by CRASC. The bypass flume (also referred to as the log sluice) can also be used to pass debris downstream.

Data are available from FirstLight from 2005-2012 regarding the timing and magnitude of gate openings for both structures; however, no data exist that relate operations to potential impacts on sturgeon spawning and rearing such as bottom velocities and sedimentation rates.

Project Nexus (18 CFR § 5.11(d)(4))

One of the two critical shortnose sturgeon spawning and rearing areas in the Connecticut River is located within the Cabot Station tailrace, within an area impacted by project discharges (Figure 3.3.12-1). Spillage events through the emergency water control gates and bypass flume (which is also used to pass migratory fish downstream) have been observed to create flow dynamics that may not be sufficiently protective of shortnose sturgeon spawning and rearing in this area. Results of this study will provide recommendations for operation of the emergency water control gates and the bypass flume that will avoid or minimize sedimentation and improve bottom velocities that are sufficiently protective of shortnose sturgeon spawning and rearing.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

This study will use a phased approach to evaluate potential impacts of spillage from the emergency water control gates and the bypass flume at Cabot Station on shortnose sturgeon spawning and rearing. Existing operations data will first be analyzed to determine whether additional field studies will be performed; if additional field data are required, a variety of flow conditions will be evaluated in the field. Control locations upstream of Cabot Station will be used to provide a baseline for comparison with areas affected by the discharges. ~~and will attempt to separate the effects of releases at the emergency water control gates and the bypass flume through the use of control locations upstream. Spill events wil be simulated and effects This study will be performed on simulated events, which will be evaluated concurrently with the instream flow study and associated bypass reach flow scenarios, as timing and schedule dictates.~~ Flow scenarios and associated measurements will be performed separately for the emergency water control gate and the bypass flume, and will be evaluated during the fall to avoid impacts by this study on sturgeon spawning.

Task 1: Preliminary Study: Analysis of Existing Data

Historic records of gate openings will be analyzed to evaluate the frequency and magnitude of spill events during the sturgeon spawning and rearing seasons. Time series data during April 15th through June 22nd from 2005-2012 will be plotted, examined, and synthesized for the emergency water control gates and the bypass flume. The results of these analyses will be presented to resource agencies before proceeding further with this study; a mutual agreement will be reached in consultation with the agencies to determine whether additional study is necessary. If non-emergency spillage events during the sturgeon spawning period are infrequent and/or of low intensity, then it may be determined that field study is not required and the study will be considered completed. Alternatively, if it is determined that additional field study is required, the study will continue to the tasks as outlined below.

Task 2: Scenario Development

Results from Task 1 will be used to select gate scenarios ~~the appropriate number and gate opening values of spill categories~~ for further analysis.~~Frequent spill events will then be categorized into separate routine operating and/or maintenance scenarios;~~ Emergency scenarios will not be evaluated in this study because changes in emergency protocols are not anticipated by FirstLight. Routine operating and maintenance scenarios that involve spillage will be selected in consultation with stakeholders prior to any potential field work, and will include various combinations of up to three flows through the emergency water control gates and the bypass flume. Each spillage scenario will also be evaluated under two bypass flow rates, and two generation flow rates for a total of up to 12 total scenarios for each of the spill locations.

Task 3: Field Verification of Conditions

Simulated events, with spillage rates identified during by Task 2, will be evaluated in the field by measuring bottom velocity and capturing sediment. To evaluate the effects of spillage events in an unbiased manner, while also accounting for spatial variability, the spawning/rearing area will be stratified based on criteria developed in consultation with the agencies. Random locations will be selected from within each stratum.

Bottom velocities at the known sturgeon spawning/rearing area (*see* Kynard et al., 2012) will be quantified using a sample of ten random locations within the spawning area; at each location, average water velocity will be measured at 1.5 feet from the bottom for 60 seconds. Additionally, average velocities will be measured in the same manner at ten random locations within the same area and under the same river flow and operational conditions, except in the absence of spillage.

To quantify sediment transport, it is envisioned that five Helley-Smith style sediment samplers with 250 micron mesh will be placed at random locations within the known spawning/rearing area (*see* Kynard et al., 2012); soak time will be determined in collaboration with resource agencies and the Conte Lab. Velocity measurements will be taken at the mouth of each net upon setting, spillage stabilization, and upon removal to aid in calculations of volume of water sampled. As a control, three nets of the same design will be placed in random locations on a shoal upstream of Cabot Station determined to be distant enough from spillway locations to be independent from spill effects; spill has been documented to induce temporary flow reversal during low discharge (Kieffer and Kynard, 2007). Samples will be strained of large-sized organic material, visually inspected, and categorized to evaluate general content, photographed, and delivered to a laboratory for subsequent analysis of dry weight.

Task 4: Data Analysis and Reporting

Descriptive statistics (mean, standard error) of measured variables will be calculated. Multiple linear regression and analysis of variance (ANOVA) will be used to determine whether conditions measured at the sturgeon spawning and rearing area are correlated with and differ significantly among spillage levels, and to determine whether and/or how covariates such as river flow or spillway operational status affect the results.

If spillage at Cabot Station is found to increase the amount of sediment flowing over the sturgeon spawning area, results from this study will be compared to the 2-D hydraulic model developed during the instream flow study in order to assess a range of potential mitigation measures.

A preliminary report containing results will be presented after the 2014 sampling data are collected and analyzed; if river flows are conducive for evaluating all proposed scenarios during 2014, then all field data collection will be performed during 2014 and the data analysis and a final report will be completed by late 2014. ~~In the event that river flows are not conducive to evaluating all flow scenarios, a preliminary report will be provided during late 2014, field work will also be performed during 2015, with a final report that includes comparisons with hydraulic model results prepared by late 2015~~

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of spillage at Cabot Station on sturgeon spawning and rearing habitat. The estimated cost for this study is approximately $5,000 if no field work is attempted, or $35,000 to $45,000 if field work is performed.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Existing data will be analyzed prior to any potential field work. Field work, if necessary, will be performed during 2014. The final report will be submitted during late 2014.

- FirstLight to conduct Task 1 Data Analysis – Winter 2014.
- Distribute summary report of results Task 1 and meet with stakeholder to determine need for field study – Spring 2014.
- If necessary, perform field investigation outside of the sturgeon spawning season - Summer 2014.

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FirstLight Power Resources
GDF SUEZ

FIRSTLIGHT POWER RESOURCES

Proposed Study Plan

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0 50 100 200 Feet

Figure 3.3.12-1: Location of the Shortnose Sturgeon Spawning and Rearing Area Near Cabot Station, and a Control Area Upstream

Path: W:\gis\maps\Study_Plans\Cabot Spillage\Figure 3.3.12-1 revised.mxd

3.3.13 Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat

General Description of Proposed Study

In their study request letters, the USFWS, NHFG, MDFW, VTDEC, Town of Gill and CRWC each requested a study of the impacts of the Turners Falls and Northfield Mountain Projects on littoral zone fish spawning and spawning habitats. FirstLight proposes a study to determine if project operations and water level fluctuations in the Turners Falls Impoundment negatively impact anadromous and resident species and to determine if negative impacts are occurring so that appropriate mitigation measures may be developed, if warranted, to protect and conserve the species utilizing project waters. Fish that may be potentially impacted includes sea lamprey, white sucker, fall fish, smallmouth bass, yellow perch, spottail shiners, bluegill, black crappie, chain pickerel, northern pike, common sunfish, and walleye. A study plan to assess sea lamprey spawning within the Turners Falls and Northfield Mountain project areas can be found in Study No. 3.3.15. This study will focus on the resident populations of temperate basses, perches, suckers, minnows and pike/pickerels in the Turners Falls Impoundment. Additional information relevant to this study will be obtained from other proposed studies, including the fish assemblage (Study No. 3.3.11), habitat mapping (Study No. 3.3.14), and tributary access (Study No. 3.3.17) studies.

It is anticipated that this study will occur during the spring and early summer of 2014 when the resident species typically spawn. Should river discharge or temperature during this period prove to be atypical (*e.g.*, outside of 25-75th percentile of average weekly flows/temp), then FirstLight will consider repeating the study in 2015 to ensure representative conditions occur during sampling to reduce bias in observations.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to collect information in order to determine if project operations negatively impact fish species so that appropriate mitigation measures may be developed, if warranted, to protect and conserve the species utilizing project waters.

Specific objective of this study are to:

- Assess timing and location of fish spawning in the littoral zone.
- Delineate, qualitatively describe (*e.g.* substrate composition, vegetation type and relative abundance), and map shallow water habitat types subject to inundation and exposure due to project operations.
- Evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals identified are to:

1. Maintain, restore, and recover populations of species of conservation and management concern to self-sustaining levels.

2. Maintain and restore the ecological composition, structure, and function of natural and modified ecosystems to ensure the long-term sustainability of populations of species of conservation and management concern.

3. Protect and conserve fish and their habitats.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Resident fish species, as well as anadromous species, identified in project waters are discussed in Sections 4.4.2-4.4.4 of the PAD. Under the FERC license, the Turners Falls Impoundment elevation may fluctuate between 176.0 ft msl and 185.0 ft msl, as measured at the Turners Falls Dam. Additionally, a bathymetric map of the Turners Falls Impoundment based in field data collection in July 2006 was developed by Hydroterra Environmental Services, LLC (see Figure 3.2.1-4 of the PAD) is available for reference.

Project Nexus (18 CFR § 5.11(d)(4))

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to Project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Information and data obtained though the proposed the fish assemblage study (Study No. 3.3.11), aquatic habitat mapping study (Study No. 3.3.14), and tributary access (Study No. 3.3.17) study will likely be used to address some of the objectives of this study.

FirstLight anticipates that this study will be conducted in the spring and early summer of 2014.

Task 1: Literature Review

Prior to conducting the field investigation, a desktop literature review will be performed to determine when resident species known to occur in the Turners Falls Impoundment typically spawn. In addition to the timing of spawning, the literature review will also be helpful for identifying typical habitat-types used by resident species for spawning, as well as spawning behavior or habits to aid in subsequent field identification.

Task 2: Field Surveys

Once spawning periods have been identified, the field survey effort will be scheduled to maximize potential observations of different species spawning activities. FirstLight anticipates a minimum of two surveying events (one in early spring and one in early summer) to capture of the spawning periods of the resident species. The exact number of surveys will be determined upon completion of the desktop literature review of Task 1.

During the May 22, 2013, Proposed Study Plan meeting, the stakeholders agreed to focus the study on the zone of reservoir fluctuation (*i.e.*, 176 to 185 ft msl) and shallower areas (less than 1 foot deep) at low pond elevation, if practical in the field (see Figure 3.3.14-1). The study will extend up to Vernon Dam. Considering the impoundment elevation may fluctuate up to nine feet due to project operations, to the extent practical, attempts will be made to conduct this study of the littoral zone when conditions are close to the minimum water surface elevation of 176.0 ft msl and maximum water surface elevation of 185.0 ft msl to ensure areas impacted by project-related water level changes are readily observable. For the purpose of this investigation, the littoral zone is depicted in Figure 3.3.14-1. This will be a general guideline, as the observable characteristics of the littoral zone can vary with water clarity, water level, time of day, and the prevailing weather conditions. The areas typically wetted when the impoundment is at the maximum allowable water surface elevation (El. 185.0') will also be observed during the field survey(s). Additionally, tributaries identified in Section 3.3.17 as accessible during spawning seasons will be observed during the field surveys.

Assuming the water clarity is conducive for visual assessment, field sampling will be conducted by systematically traversing the littoral zone of the Turners Falls Impoundment via boat and/or foot (wading) to visually identify any fish nests, egg masses/deposits, and/or spawning habitat. Additional necessary equipment and data collection will include:

- a digital camera for photo-documentation of habitat types, egg deposits, and identified nests;
- an underwater Atlantis™ Panning Camera and/or view tubes to identify spawning nests/habitats in those instances where they cannot be easily identified from the surface;
- a handheld GPS unit to geo-reference the locations of identified habitats, egg deposits, and nests;
- a handheld water quality meter to measure water temperature;
- a Marsh-McBirney flow meter to measure velocity at identified spawning habitats, egg deposits, and nests;
- a secchi disk to estimate water clarity;
- a stadia rod and/or depth meter for recording depth of identified spawning habitats, egg deposits, and nests; and
- data sheets for recording water quality parameters, general observations, weather conditions, and other relevant descriptive information (e.g., sediment/grain sizes associated with nests, embeddedness, approximate diameter of identified nests, presence of fish at nests, presence of aquatic vegetation, nest abandonment, sedimentation of eggs, etc.).

These data will be recorded on standardized, waterproof field data sheets. Upon completion of the field survey, all data sheets will be reviewed for quality assurance. Data necessary to develop a map of the observed spawning habitat, egg deposits and fish nests relative to the areas subjected to dewatering due to project operations will be electronically transcribed. A report containing a discussion of the impacts of water level fluctuations on the resident species spawning and spawning habitat, including potential nest abandonment, spawning fish displacement and egg dewatering, in the Turners Falls Impoundment will be produced.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Northfield Mountain Project and Turners Falls Project on fish spawning and spawning habitat in the investigation area. The estimated cost for this one-year study is approximately $25,000-35,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight anticipates that this study will be conducted in the spring and early summer of 2014, after high spring flow conditions have subsided.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.3.14 Aquatic Habitat Mapping of Turners Falls Impoundment

General Description of Proposed Study

FERC requested aquatic habitat mapping of the Turners Falls Impoundment, which compliments requests by other stakeholders as described in Study No. 3.3.13 and Study No. 3.5.1. FirstLight proposes to conduct a habitat field survey to delineate aquatic littoral and demersal habitat in terms of substrate and cover in the Turners Falls Impoundment.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The purpose of the study is to map the distribution and abundance of aquatic habitat within the Turners Falls Project impoundment in the Connecticut River, evaluate the types of aquatic habitats that occur there, and identify any potential effects of operations of the Turners Falls Project and Northfield Mountain Project on this habitat. The habitat mapping and accompanying characterization of aquatic mesohabitat will provide essential information regarding the character and extent of aquatic habitat that may potentially be affected by Project operation. The quantified spatial data generated by this survey will help to provide a framework for upcoming data analysis efforts relative to operations and impoundment modeling.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The FERC must decide whether to issue a new license to FirstLight for the Turners Falls and Northfield Mountain projects in the Connecticut River. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. Aquatic habitats in the Connecticut River support a sustainable riverine ecosystem that provides public opportunities, including a sport fishery. Ensuring that the effect of project operations pertaining to this resource is considered in a reasoned way is relevant to the Commission's public interest determination.

Several resource agencies have submitted applicable management goals in their study request letters. Resource management goals for this study are consistent with those identified in Study No. 3.5.1 *Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species.*

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

No prior habitat mapping information is available to document the habitat resources of the Turners Falls Impoundment. Mapped locations of aquatic habitats in the Turners Falls impoundment is needed to evaluate the potential influences of the Turners Falls and Northfield Mountain Project on aquatic resources.

Project Nexus (18 CFR § 5.11(d)(4))

Water levels in the Turners Falls impoundment fluctuate due to operations of the Turners Falls Project and because the impoundment also serves as the lower reservoir for the pumped-storage operations of the Northfield Mountain Project. As a result, littoral aquatic habitat and aquatic species that utilize the habitat may be affected by water level fluctuations. This study will establish a baseline condition and the health of the aquatic habitat and aquatic species of the Connecticut River in the Turners Falls Impoundment under current operations.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

FirstLight proposes to map the distribution and abundance of littoral aquatic habitat within the Turners Falls Project impoundment in two phases. During the first phase, major aquatic habitat types will be delineated. During the second phase detailed microhabitat data will be collected on representative transects. These data will then be used in conjunction with operational and other models to evaluate project effects on aquatic resources in the study area. During the May 22, 2013, Proposed Study Plan meeting, the stakeholders agreed to focus the study on the zone of reservoir fluctuation (*i.e.*, 176 to 185 ft msl) and shallower areas (1 foot deep) at low pond elevation, if practical in the field (see Figure 3.3.14-1). The study will extend up to Vernon Dam.

Task 1: Field Survey

Lentic aquatic habitat suitability is defined primarily by substrate, cover and depth. Each of these habitat parameters will be assigned specific attributes to be used for field delineation. These will generally include:

- **substrate:** substrates will be identified visually in shallower areas. In deeper water, substrate composition will be determined with an underwater camera, use of a ponar dredge, or through use of a sediment probe to generally classify substrates (*i.e.*, as fines or loose rock or bedrock/boulder). Dominant substrates in each habitat type will be identified using the following standard particle classification scheme (based on Wolman, 1954):
    - **Silt/Clay** – any particle less than .062 mm across.
    - **Sand** – any particle .062 mm to 2.0 mm across.
    - **Gravel** – any particle 2.0 mm to 64 mm across.
    - **Cobble** – any particle 64 mm to 256 mm across.
    - **Boulder** – any particle 256 mm to 2048 mm across.
    - **Bedrock** – any particle greater than 2048 mm across.

  Where there are multiple substrate types, each substrate class will be assigned a relative percent dominance within individual habitats.

- **cover type:** object cover (*i.e.* boulder, woody debris, riprap, etc.), overhead cover (overhanging limbs, structures, etc.); vegetative cover (emergent, submerged)
- **cover density:** absent, low, moderate, high
- **depth (at normal pool):** surface to substrate (ft)

Task 1a: Delineation

Delineation of the 20-mile-long impoundment will be conducted by boat and will occur during summer during a period of relatively stable impoundment levels so that aquatic vegetation is established, and so that observations of depth relative to substrate and cover can be observed under consistent conditions, to the extent practical.

Habitat delineation will be conducted by a boat traveling through the littoral zone parallel to shore. The prevailing water elevation at the beginning of the survey will be documented by bench-marked survey. Staff gages will be established throughout the study area so that changes in water elevation during the survey can be accounted for. The field crew will methodically record habitat attributes and geo-reference with GPS each boundary where a pronounced change in substrate and/or depth occurs. We anticipate that cover will occur in patches rather than broad linear boundaries. Therefore, a centroid GPS waypoint will be collected at key cover nodes.

Additional relevant biological and geomorphic characteristics will also be collected where appropriate including readily observable aquatic fauna; channel geometry (including bank and shoreline slope); etc. The data will be recorded on data sheets, a dedicated field book, or via a pentop computer. Upon completion of the survey, all data will be rechecked for quality control and archived.

Task 1b: Microhabitat

Transect data will be gathered within representative littoral areas. The distribution and number of transects will be dictated by the variability detected during the delineation phase, but the goal would be to have one transect accounting for each major type of shoreline slope/littoral substrate/cover/depth condition documented during delineation. Each transect will extend from El. 185' to El. 176' and include the area to a water depth of approximately one foot deep under low impoundment elevation (176’). Verticals will be located along each transect to depict the following elevations:

- top of bank
- normal high water
- upper elevation of pool (if different than normal high water)
- normal pond elevation
- toe of bank
- Low pool elevation.

Additional verticals will be established at intervals wherever micro-changes in slope, substrate embeddedness, or cover are encountered. Elevations will be surveyed in project datum so that data can be integrated with other project operation data for analysis. The locations of all transects will be geo-referenced with GPS and transect headpins marked with blazing.

Task 2: Analysis and Report

Geospatial mesohabitat data will be transferred to a GIS format and used to develop both visual maps depicting distribution as well as tabular information quantifying the abundance and distribution of habitat features in the study area. A summary report will be developed that will include survey methods, GIS maps showing the mesohabitat spatial distribution in the impoundment, and a discussion of observations. The report will provide a narrative discussion of habitat use by aquatic fish and macroinvertebrates native to the study area. It is anticipated that data gathered during Study No. 3.3.17 *Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat* will also be used to develop the habitat map and discussion for this summary report.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The estimated cost for the study outlined in this plan is approximately $30,000-$45,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

It is anticipated that the aquatic mesohabitat assessment and mapping survey will be conducted in July – August 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

Wolman, M.G., 1954. A method of sampling coarse river-bed material. Transactions of American Geophysical Union 35.

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IMPOUNDMENT HABITAT STUDY

Figure 3.3.14-1
Littoral Zone Study Area

Page 1 of 23

Legend

- Littoral Zone Study Area
- Littoral Zone Study Area*

* Area to be examined in field to determine littoral extent.

N

Littoral Zone Study Area data was created based on a hydraulic model of the Turners Falls impoundment. Boundary conditions were defined based on HEC-RAS model output for scenarios of water surface elevation 176' and 185' at the Turners Falls Dam (the currently permitted operating range) at inflow of 1,433 cfs and includes areas that are one foot deep or less under the minimum elevation of 176' at an inflow of 1,433 cfs. Above the Ashuelot River, the Littoral Zone Study Area includes the entire channel due to poor bathymetry coverage and limited effects of the fluctuations at the Turners Falls Dam under the model scenarios stated above. Therefore, the area above the Ashuelot River will be examined to determine littoral zone extent in the field.

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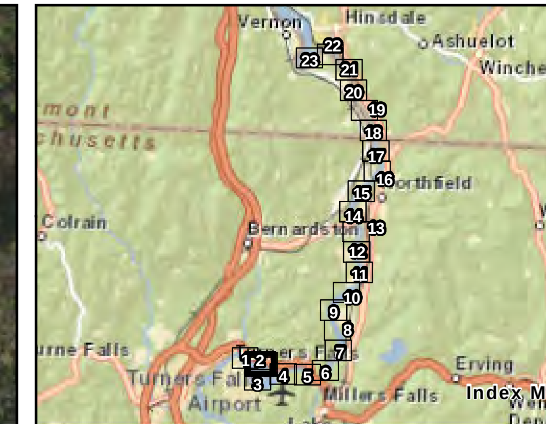

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Figure 3.3.14-1
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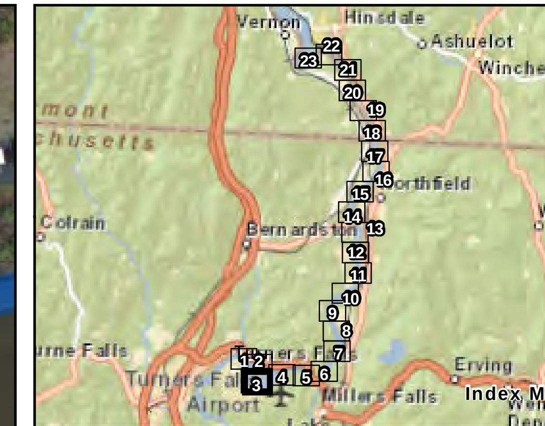

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Figure 3.3.14-1
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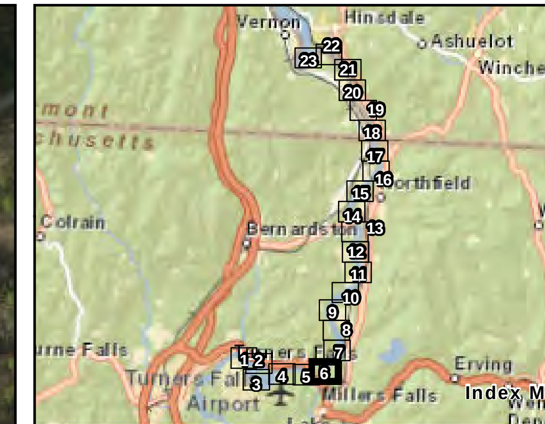

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IMPOUNDMENT HABITAT STUDY

Figure 3.3.14-1
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FIRSTLIGHT POWER RESOURCES
IMPOUNDMENT HABITAT STUDY

Figure 3.3.14-1
Littoral Zone Study Area

Page 10 of 23

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Littoral Zone Study Area

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FIRSTLIGHT POWER RESOURCES
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Figure 3.3.14-1
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FIRSTLIGHT POWER RESOURCES
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Figure 3.3.14-1
Littoral Zone Study Area

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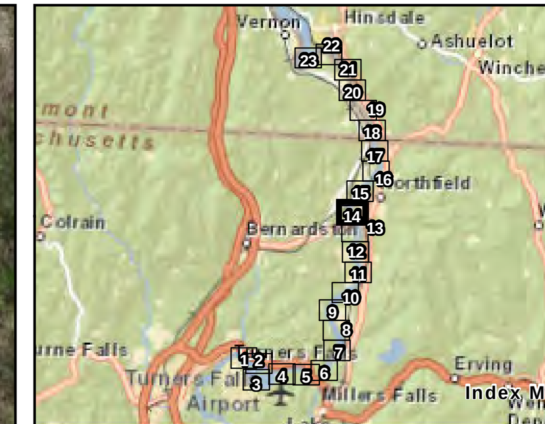

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IMPOUNDMENT HABITAT STUDY

Figure 3.3.14-1
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FIRSTLIGHT POWER RESOURCES
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Figure 3.3.14-1
Littoral Zone Study Area

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FIRSTLIGHT POWER RESOURCES
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Figure 3.3.14-1
Littoral Zone Study Area

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Figure 3.3.14-1
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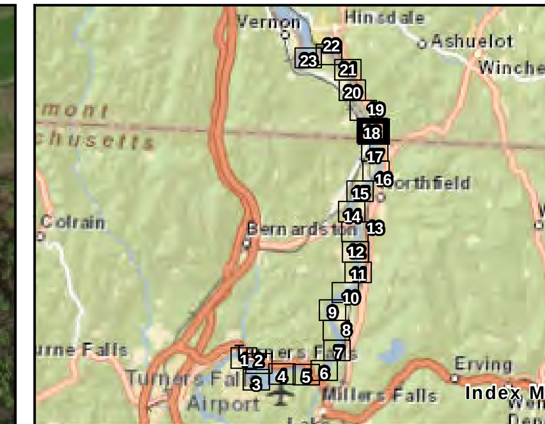

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IMPOUNDMENT HABITAT STUDY

Figure 3.3.14-1
Littoral Zone Study Area

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Littoral Zone Study Area

Littoral Zone Study Area*

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FIRSTLIGHT POWER RESOURCES
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FIRSTLIGHT POWER RESOURCES
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Figure 3.3.14-1
Littoral Zone Study Area

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Figure 3.3.14-1
Littoral Zone Study Area

Page 21 of 23

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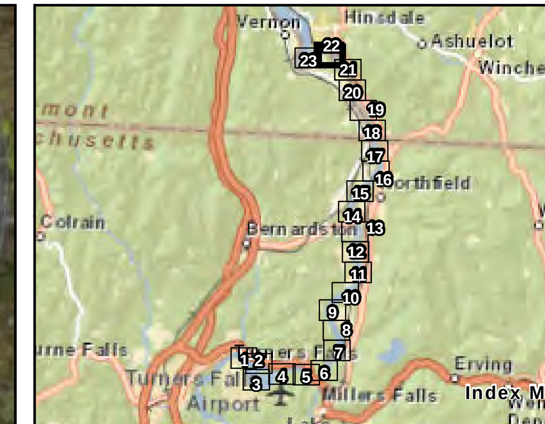

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Figure 3.3.14-1
Littoral Zone Study Area

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Littoral Zone Study Area

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FIRSTLIGHT POWER RESOURCES
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Figure 3.3.14-1
Littoral Zone Study Area

Page 23 of 23

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3.3.15 Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area

General Description of Proposed Study

NOAA requested an assessment of adult sea lamprey spawning within the areas of the Turners Falls and Northfield Mountain Projects. FirstLight will conduct a field study to assess adult sea lamprey spawning within those areas during the late spring or early summer of 2014, but is proposing to substitute the methods described below in lieu of the telemetry methods suggested by NOAA.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine the impacts that operations of the Turners Falls Project and Northfield Mountain Project may have on sea lamprey spawning activity. Specific objectives of the study are to:

- Identify areas within the Project area where suitable spawning habitat may exist for adult sea lamprey.
- Conduct spawning surveys to confirm use of areas identified as containing suitable spawning habitat.
- Describe spawning mound characteristics, including location, size, substrate, water depth, and velocity.
- Collect the information to assess whether operations of the Turners Falls Project and Northfield Mountain Project are adversely affecting spawning areas (*i.e.*, if flow alterations are causing dewatering and scouring of lamprey spawning area).

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Sea lamprey are a federal trust resource, and as such, NOAA Fisheries is charged with protecting the species and reducing threats to maintain its population. According to NOAA Fisheries, sea lamprey within the Connecticut River drainage are one of New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). As outlined in Vermont's Wildlife Action Plan, research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Sea lamprey are an anadromous species known to spawn in the Connecticut River within the Turners Falls and Northfield Mountain Project Areas. They use mainstem and accessible tributary habitat consisting of gravel and cobble substrate in areas with flowing water in which they construct nests during spawning (NOAA, 2013). Sea lamprey pairs or groups (multiple fish may form an aggregate nest) can be observed building nests (or recently completed nests can be observed) in late-June (Hartel et al., 2002; NOAA, 2013). Lamprey spawning has been observed from the Sunderland Route 116 bridge upstream to Cabot Station in shallow water habitats where preferred substrate occurs and where water velocities are increased due to a riverine physical characteristics (*e.g.*, shifts in depth contours, channel meanders, or islands) (NOAA, 2013). According to NOAA, the Connecticut River Coordinator (K. Sprankle, USFWS) has observed sea lamprey spawning in the Connecticut River mainstem upstream of the Turners Falls Dam within close proximity of the Vernon Dam (suitable habitat adjacent to Stebbins Island, both sides of island) (NOAA, 2013). Sea lamprey are also known to utilize lower reaches of tributaries, such as the Ashuelot River, Hinsdale, New Hampshire and mainstem gravel bar and shallow water habitats within the Turners Falls Impoundment (*e.g.*, Massachusetts State Line) (NOAA, 2013).

Many years of lamprey count data exist, the most recent being 2012, when 14,089 sea lamprey were passed upstream of Holyoke Dam, whereas 4,503 were passed at Turners Falls Dam. To date, no studies have been conducted that identify sea lamprey spawning habitat and/or activity or the effects of operations of the Turners Falls Project and the Northfield Mountain Project on spawning (NOAA, 2013).

FirstLight conducted studies in the late spring and summer of 2012 to examine habitat conditions downstream of Turners Falls Dam, including substrate composition. Habitat mapping indicated there is limited gravel-riffle spawning habitat in the mainstem downstream of Cabot Station or within the bypassed reach below Turners Falls Dam (FirstLight, 2012).

Project Nexus (18 CFR § 5.11(d)(4))

Operations of the Turners Falls and Northfield Mountain Projects have the potential to affect sea lamprey spawning activity, spawning habitat, and spawning success. If adult sea lamprey are actively spawning in the project area, it is important to assess whether Project operations are having any adverse effects (*i.e.*, dewatering and scouring) to these spawning activities, their nests, and spawning habitats.

The investigation area includes the following:

- Suitable gravel or cobble riffle habitat within the Connecticut River mainstem from Cabot Station downstream to Sunderland Bridge.
- Suitable gravel or cobble riffle habitat the Turners Falls bypassed reach (Connecticut River mainstem).
- Suitable gravel or cobble riffle habitat within the riverine portion of the upper Turners Falls Impoundment that is subjected to flow or elevational regulation resulting from project operations. Specifically, surveyors will focus in on the following three areas:
  a. The Connecticut River mainstem within close proximity of the Vernon Dam (habitat adjacent to Stebbins Island, both sides of island).
  b. Mainstem gravel bar and shallow water habitats within the Turners Falls Impoundment (*e.g.*, at or near the Massachusetts State Line and the railroad bridge gravel bar).
  c. Suitable spawning habitat in the vicinity of Rawson Island.

- Suitable gravel or cobble riffle habitat within tributary confluence areas that are or may be affected by the current operational protocols, including:
  a. The Deerfield River confluence with the Connecticut River.
  b. The Millers River confluence with the Connecticut River.
  c. The Ashuelot River confluence with the Connecticut River.
  ~~c.~~d. The Fall River confluence with the Connecticut River.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Field Data Collection

Assessment of Sea Lamprey Spawning Activity and Habitat – Because sea lamprey nests and spawning pairs are generally readily observable (S. Coghlan, Assistant Professor of Freshwater Fisheries Ecology, University of Maine, personal communication, March 15, 2013) spawning activity will be determined via wading or boating surveys within the investigation area. Given sea lamprey life history and spawning patterns, it is anticipated that spawning ground surveys will be performed in late May or June, depending on water temperature and river flow. Surveyors will:

- Delineate areas of suitable habitat for lamprey (shallow, gravel or cobble riffles) with a sub-meter accuracy GPS.
- Physically locate and enumerate active or inactive nests.[40]
- Physically locate actively spawning lamprey.
- Photo document, geo-reference, and physically mark (with fluorescent marker or other re-locatable marking device) active and inactive nests.
- Collect habitat data at representative nest sites including:
    - Nest dimensions (length/width), along with measurements of depth and velocity at the upstream end, top of mound, and bottom of pit.
    - Substrate classification.
    - Water temperature.

Once nests and spawning habitat are located and delineated, surveyors will return to a sub-sample of at least 30 randomly distributed individual nests (if available) throughout the investigation area during low water level conditions following a high-flow operational event to assess whether operations affect spawning habitat or cause nest abandonment. During the selection of the 30 nests, preference will be given to areas most likely to be impacted by project operations. The potential impacts of Project operations on nesting success will be assessed through the use of appropriate statistical techniques (e.g., ANOVA, regression, t-tests) to compare variables and to determine which factors, if any, are more likely to affect success (i.e., shallow vs. deep nests, dominant substrate). To ensure adequate spatial coverage and the evaluation of lamprey nests in multiple locations, the subsample will be divided among different large-scale location classifications (i.e. Turners Falls Impoundment; Bypass Reach; Downstream Corridor, etc.), with a goal of subsampling at least 10 nests in each determined location. At these stations, surveyors will:

- Photo document active and inactive nests during low water level conditions.
- Collect habitat data during low water level conditions to document changes resulting from Project operations, including:
    - Number of nests dewatered, partially or wholly.
    - Nest dimensions (length/width), along with measurements of depth and velocity at the upstream end, top of mound, and bottom of pit.
    - Water temperature.

[40] For the reach of the mainstem Connecticut River downstream of Cabot Station and below Vernon Dam, this will include using existing habitat data collected by FirstLight in 2012 or information related to known spawning sites to identify suitable habitat in advance of field surveys.

- Delineate remaining wetted areas of suitable habitat (*i.e.*, spawning beds) for lamprey (shallow, gravel or cobble riffles) with a sub-meter accuracy GPS unit during low water level conditions for determinations of areal loss of habitat.

- Scouring of nests will be evaluated through physical measurements of nest dimensions, water depth, and water velocity after a high-flow event to assess whether nests have been physically disturbed by increases in discharge. Shear stresses for dominant substrate types at each of the 30 nests will be determined by a professional hydraulic engineer using existing bed load shear stress relationships. This information will be used to determine the likelihood of bed load mobilization or scour.

Task 2: Data Analysis

All field data will be compiled, entered into a database, assured for quality, and archived. Tabular and graphic summaries of sea lamprey abundance and a map of the spatial distribution of suitable habitat will be developed.

Task 3: Report

A report will be prepared describing monitoring methods and results. The report will also include an assessment of impacts due to Project operations and whether changes to operational regimes could reduce potential adverse impacts to sea lamprey spawning and spawning habitat.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Turners Falls Project and Northfield Mountain Project on sea lamprey spawning in the investigation area. The estimated cost for this one-year study is approximately $30,000 to $45,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight anticipates that this study will be conducted in late May or June of 2014, depending on water temperature and river flow conditions, which corresponds with sea lamprey spawning timeframes in the Connecticut River.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

FirstLight Hydro Generating Company (FirstLight). (2012). *Aquatic Mesohabitat Assessment and Mapping*. Northfield, MA: Author.

Hartel, K.E., D.B. Halliwell, & A.E. Launer. 2002. Inland Fishes of Massachusetts. Massachusetts Audubon Society (Lincoln). 328 pp.

NOAA. 2013. Letter with Comments on FirstLight Power Resources Notice of Intent to File License Application dated February 27, 2013.

3.3.16 Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station

General Description of Proposed Study

MADFW requested a study investigating the effects of flow regime on state-listed freshwater mussels, or potential habitat, downstream from the Turners Falls Dam. Although the geographic scope of such a study was not defined in the MADFW study request, FirstLight defines the study area as the 13-mile reach between Cabot Station and the Route 116 Bridge in Sunderland. A two-phase approach is proposed for this study. In Phase 1, the study area will be surveyed for state-listed mussels using approved survey protocols; biologists will characterize populations of state-listed and co-occurring common mussel species, describe habitat conditions, and map/analyze habitat for any state-listed mussel species found in the study area. Phase 2 will focus on more detailed habitat measurements in areas where state-listed mussel species are found, and combine these data with hydraulic modeling and IFIM studies (described under separate study plans) to assess potential effects of the current flow regime on state-listed mussel populations or their habitat.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

This study has two objectives that can be accomplished in two phases:

- Phase 1: Delineate, through field surveys, populations of state-listed mussels downstream from Cabot Station and employ methods to characterize the distribution, abundance, demographics, and habitat use of these populations. Even if state-listed mussel species are not detected, surveys will identify and map potential habitat for state-listed species based on habitat preference of each species.
- Phase 2: Collect more detailed data on mussels and habitat parameters in areas where state-listed species are found, and combine these data with the independent hydraulic model and IFIM studies, to evaluate the effects of existing and potential flow regimes on state-listed mussel species.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The Massachusetts Natural Heritage & Endangered Species Program (NHESP), part of the MADFW, is charged with ensuring the conservation and protection of species listed under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) as Endangered, Threatened, or of Special Concern. The resource management goals identified by the NHESP/MADFW are to:

- Ensure that PME measures are commensurate with Project effects and meet MESA requirements.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations.

The MADFW study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, PME measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Species Composition: In 2011, a freshwater mussel survey was conducted in the Turners Falls Impoundment, bypass reach, and canal as a baseline study in anticipation of the FERC relicensing process. State-listed mussel species were not detected in any of these areas (Biodrawversity, 2012). Also in 2011, a freshwater mussel survey was conducted upstream and downstream of the Vernon Hydroelectric Project as part of the planning for TransCanada's FERC relicensing process, and no state-listed mussel species were found during that study (Biodrawversity & LBG, 2012). As part of the requirements of the FERC license for the Holyoke Dam, freshwater mussel studies have been conducted at four-year intervals in that project area, which includes the area from Dry Brook (Sunderland) to the Holyoke Dam, plus the bypass reach and power canals (this survey is scheduled to occur again in 2013). These studies, combined with surveys conducted for several riverbank stabilization or construction projects along this same reach, have resulted in a very good understanding of the distribution and habitat of common and state-listed mussel species in the Connecticut River from the Holyoke Dam to the Vernon Dam, minus a mostly unsurveyed 13-mile reach from the Route 116 Bridge in Sunderland to Cabot Station.

The yellow lampmussel (*Lampsilis cariosa*), listed as Endangered in Massachusetts, has been documented in the impoundment of the Holyoke Dam as far upstream as the Hadley Dike, with highest concentrations from Elwell Island (Northampton) downstream to Brunelle's Marina (South Hadley). The eastern pondmussel (*Ligumia nasuta*) has been found at only one location in the lower Holyoke Dam impoundment, and it occurs in several small tributaries. There is potential for either of these species to occur in the Connecticut River in the unsurveyed 13-mile reach downstream from Cabot Station. In addition, there is a historic record (~1978) of dwarf wedgemussel (*Alasmidonta heterodon*) in the Connecticut River at Sunderland, and it is possible that this species still persists in this reach. This is a federally endangered species, with the closest known populations in the Fort River (Amherst, MA), Mill River (Hatfield, MA), Ashuelot River (Swanzey, NH), and in the Connecticut River in the impoundment of the Bellows Falls Dam in New Hampshire and Vermont.

Impact of Flow Regime: The impacts of current flow regime on mussels downstream from the Turners Falls Dam are not well understood. There are significant within-day flow fluctuations downstream from the Turners Falls Dam. These changes in water elevations and flow dynamics have the potential to adversely affect state-listed mussels, their habitats, and their long-term viability in the Connecticut River. Species most vulnerable would be those that have an affinity for nearshore habitats, or other shallow areas that are most likely to become dewatered or shallow enough to make individuals vulnerable to heat stress or predators during periods of low flow. Effects are expected to be most acute in areas of the river with channel morphometry, bank slope, and substrate conditions that are both conducive to mussel colonization and that experience the greatest degree of change from flow minima to flow maxima. The IFIM and hydraulic models studies proposed for this project, combined with the mussel surveys and habitat assessments that will be completed specifically during the mussel study, will help to identify both the species and locations where flow regime effects are more likely to occur, and will help provide an overall assessment of these effects.

Project Nexus (18 CFR § 5.11(d)(4))

The timing, rate, and magnitude of releases from the Turners Falls Project may have adverse effects on rare mussel populations although the degree of these effects is unknown. Baseline information is needed to evaluate the potential impacts of the Project on the abundance and distribution of state-listed mussel species and their habitat.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Finalize study plan and attain collection permit

Because the study is focusing on state-listed mussel species, FirstLight will work with NHESP to finalize the study plan and attain the necessary permit to handle/collect state-listed mussels. FirstLight will comply with the conditions and reporting requirements of the collection permit.

Task 2: Phase 1 Mussel Survey and Habitat Assessment

Surveyors will systematically search the open water riverine habitats downstream from Cabot Station, employing the following protocol:

- The survey will be conducted when appropriate water clarity and water depth conditions are present, between early June and late September.
- Surveys will be conducted using SCUBA in depths over three feet, and by snorkeling in shallower waters.
- At least one site per mile, with additional sites in complex areas (such as around islands) will be surveyed for a minimum of 1.0 person-hours of survey effort per site. Additional time will be spent surveying areas where state-listed species are found to characterize and delineate these populations. Typically, 200-meter sections are surveyed during one-hour timed searches.
- The Catch per Unit Effort (CPUE) method will be used to qualitatively assess mussel species abundance. Specifically, the number of individuals of each species encountered within a defined amount of time will be tallied, and the CPUE values will be calculated and compared.
- Standard morphometric data (e.g., species, size, shell injury/erosion etc.) and site data (i.e., location, extent, elevation, and age class structure) will be collected. All state-listed mussel species encountered, and the first 50 individuals of common species, will be measured (mm) to enable assessment of size distribution and recruitment.
- For each state-listed mussel that is encountered, the following data will be recorded: precise location, water depth, substrate, presence/abundance of aquatic plants, presence/abundance of woody debris, and flow velocity.
- Representative digital photographs of each state-listed species will be taken at each site to document and confirm the identity. Photos showing the lateral view and/or in situ siphoning will be included.
- Representative samples of spent shells (if encountered) will be collected for each state-listed species; these will be sent to the Division for documentation.
- All mussels removed from the substrate will be replaced to the same area and carefully re-bedded into the sediment in their original orientation; anteriorly into the substrate, posterior end up.
- At all survey sites, biologists will record key instream habitat parameters such as water depth, flow velocity, major substrate types, aquatic plant species/abundance, abundance of woody debris, bank condition, and representative photographs.
- This general habitat assessment will provide habitat descriptions and maps to adequately describe the relative amount, distribution, and quality of suitable habitat for the state-listed freshwater mussels in areas influenced by the Turners Falls Project.

Task 3: Phase 2 Habitat Assessment and Mussel Survey

The Phase 2 habitat assessment and possible additional mussel surveys (e.g., quantitative surveys) will only be conducted at sites where state-listed mussel species are found. Given the potential to find either state-endangered or federally endangered mussel species, we think it is prudent to only outline a Phase 2 approach and commit to working with MADFW or USFWS to refine this approach listed below depending on Phase 1 results.

- Additional habitat data will be collected to support the IFIM study. Specifically, depth, velocity, and substrate profile(s) will be recorded at one or more cross-channel transects; the number of transects will depend on the size of the mussel bed and habitat complexity at a site.
- Both the boundaries of mussel beds and the wetted area will be delineated using GPS.
- If state-listed mussel densities are high enough, quantitative sampling (using quadrats or transects) will be employed to provide a more accurate assessment of density and population size at that location.

Task 4: Effects of Flow Regime on State-listed Mussels

The IFIM (see Study No. 3.3.1 – applicable to reaches 1-4) and hydraulic model (see Study No. 3.2.2 – applicable to Reach 5) studies proposed for this project, combined with the mussel surveys and habitat assessments that will be completed specifically during the mussel study, will help to identify where Project effects are more likely to occur, which species are more susceptible, and will help provide an overall assessment of these effects.

If state-listed mussels are detected and the Phase 2 mussel survey is completed, the IFIM and hydraulic models will be supplemented with the detailed habitat data collected at the sites where state-listed mussels are found, resulting in a more comprehensive assessment of the effects of flow regime on state-listed mussels.

Task 5: Report

A report will be prepared describing the survey and modeling methods and results. A tentative table of contents follows:

- Introduction
- Study Area
- Methods
    - Mussel Surveys
    - Habitat Assessment
    - Hydraulic Model and IFIM
- Results
    - Mussel Surveys
    - Habitat Assessment
    - Effects of Flow Regime
- Discussion
- Conclusions

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The methods and analyses proposed are consistent with other studies of this nature. The estimated cost for this study will depend, in part, on whether state-listed mussel species are found and the amount of mussel/habitat data that must be collected where state-listed mussels are found. Overall costs may range $15,000 - $60,000 (not including the hydraulic model and IFIM completed as a separate study). The cost for the Phase 1 mussel survey and habitat characterization would comprise the low end of that range; higher costs would likely only result from the discovery of state-listed mussels and the necessity of a Phase 2 mussel survey.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Field work for the Phase 1 mussel survey is planned to occur in 2013, if possible, in advance of the instream flow study proposed in Study No. 3.3.1. Completing the Phase 1 survey early in 2013 will help to determine if and where the Phase 2 mussel surveys are needed, and help inform the instream flow study. The remainder of any necessary work will occur in 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

Biodrawversity, (2012). *Freshwater Mussel Survey in the Connecticut River for the Turners Falls and Northfield Mountain Hydroelectric Projects*. Amherst, MA: Author.

Biodrawversity and The Louis Berger Group, Inc. (LBG). (2012). *Freshwater mussel survey in the Connecticut River for the Vernon, Bellows Falls, and Wilder Hydroelectric Projects*. Prepared for TransCanada Hydro Northeast Inc.

3.3.17 Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat

General Description of Proposed Study

The NHFGD, Town of Gill, MADFW, CRWC, VTDEC, TU and USFWS requested a study to determine if water level fluctuations due to Project operations result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below the dams. Additionally, the stakeholders requested an assessment of the impacts of water level fluctuations due to Project operations on water levels, available fish habitat and water quality in the tributaries and backwaters of the impoundment and riverine reaches below the dams. It is anticipated that this study will provide data that may be used to determine the adequacy of existing downstream minimum flow requirements.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals of this study are to determine if water level fluctuations from the Turners Falls and Northfield Mountain Projects result in reductions of available aquatic habitat due to movement barriers and/or habitat alterations. Results from this study will be useful for developing mitigation measures and to determine the adequacy of existing downstream minimum flow requirements. Specific objectives of the study are to:

1. Identify potential barriers or constrictions of fish access to tributaries and backwater areas resulting from Project-related water level fluctuations.

2. Measure changes to available habitat, and water quality in backwater areas and tributaries resulting from Project-related water level fluctuations.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals identified by the commenting agencies are:

- Protect, enhance, or restore diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Major tributaries to the Turners Fall Impoundment include the Ashuelot River in New Hampshire, which drains 420 mi^2 from the east and enters the Connecticut River just below Vernon Dam, and the Millers River, which drains 392 mi^2 from the east and enters downstream of the Northfield Mountain tailrace. Smaller named streams entering the Turners Falls Impoundment, from upstream to downstream, include Newton Brook, Pauchaug Brook, Bottom Brook, Mill Brook, Mallory Brook, Millers Brook, Bennett Brook, Merriam Brook, Otter Run, Ashuela Brook, Dry Brook, Pine Meadow Brook, and Fourmile Brook. For the downstream reach from the base of the dam to the Route 116 bridge, major tributaries potentially impacted by Project operations include the Fall River, Deerfield River, Sawmill River, and Gunn Brook.

Limited information related to the potential impacts of the Turners Falls Project and Northfield Mountain Project operations on tributary/backwater access and habitats is available; therefore, the study is being completed to establish baseline conditions and assess the potential effects of existing or proposed operations. Given that the major tributaries to the Connecticut River in the project area (*i.e.*, Deerfield River, Miller River, and Ashuelot River) are large, regulated, and gauged river systems with ample catchment size, it is assumed that access to these major systems is afforded during all operational phases of the Turners Falls Project and Northfield Mountain Project. Therefore, the study will focus on smaller tributary systems that may not have enough river flow to maintain connectivity during drawdown periods.

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and Northfield Mountain Project may directly impact tributary/backwater and aquatic habitat access through the use of water for hydropower generation.

The investigation area includes the following smaller named streams entering the Turners Falls Impoundment, from upstream to downstream (Figure 3.3.17-1)[41] as well as significant backwatered areas within the Turners Falls impoundment:

- Newton Brook
- Pauchaug Brook
- Bottom Brook
- Mill Brook
- Mallory Brook
- Millers Brook
- Bennett Brook
- Merriam Brook
- Otter Run
- Ashuela Brook
- Dry Brook
- Pine Meadow Brook
- Fourmile Brook
- Backwater habitat encountered during survey work.

Investigation areas downstream of Turners Falls Dam will include the Fall River, Deerfield River, Sawmill River, and Gunn Brook (*see* Figure 3.3.17-2).

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Common tools to evaluate water level impacts may be used including: bathymetric mapping; habitat measurements (*e.g.*, substrate, depth and velocity), and water quality information (*e.g.*, dissolved oxygen, temperature, turbidity, and pH). Other methods (river bed surveys, visual inspections, GIS/GPS mapping, and hydraulic/habitat modeling) will also be utilized. The study area for tributary and backwater sampling will include 13 smaller named tributaries along with other significant backwater habitat encountered during the surveys. All field work described below would be performed once during the spring, summer, and fall of the first study year.

[41] Assumes all of these tributaries are locatable.

Task 1: Field Data Collection

For the purpose of this study, low water level conditions will be considered as 176.0 feet msl (or as close as is practical at the time of the study) in the Turners Falls Impoundment, and at a gage height of ≤ 8 feet at Montague for river reaches below the Turners Falls Dam.

Tributaries – Surveyors will locate individual tributary confluence areas within the Turners Falls Impoundment and the downstream reach to the Route 116 Bridge by boat or vehicle/foot during full-pond conditions or high water level conditions downstream. At each tributary site, surveyors will perform the following:

- Photo document the tributary confluence area.
- Delineate the perimeter of the inundated tributary confluence area with a sub-meter accuracy GPS. Aerial imagery may also be used to delineate tributary confluence areas.
- Perform bathymetric measurements of the confluence area of individual tributaries, including thalweg.
- Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH at one location within the inundated tributary confluence area. For comparison, measurements will also be taken at one location in the Connecticut River near the confluence area and in a free-flowing riverine reach immediately above the elevation affected by water level fluctuations.

Surveyors will then revisit tributary confluence areas during lower water level conditions (*i.e.*, low pond and low discharge in the Connecticut River) to determine if stream intermittency or constrictions occur as a result of Project operations that would restrict fish movements into free-flowing riverine reaches. At each tributary site, surveyors will perform the following:

1) Photo document the tributary confluence area and any stream channel features (*e.g.*, barriers) that may restrict fish movements. Assessment and identification of these constriction points will be based on the best professional judgment of the biological staff employed to do the work. Generally, stream features with water depths less than 1 foot in the thalweg area will be considered as potential constrictions to fish movements.[42]
2) Delineate the perimeter of the dewatered tributary confluence areas with a sub-meter accuracy GPS. Aerial imagery may also be used to delineate tributary confluence areas. Critical transects will also be GPS-located for future reference.
3) Characterize and map exposed aquatic habitats in the tributary confluence area.
4) If barriers to fish movement are observed:
    - Record and photo document their location.
    - Perform a longitudinal bathymetric/topographic thalweg[43] survey of the dewatered confluence area, with stream bed elevations relative to low water level elevation.
    - Perform a cross-sectional profile of stream channel features that may restrict fish movements.

[42] Given that these small tributaries are likely only used by resident riverine fish and perhaps sea lamprey, water depths greater than 1 foot will be considered adequate for upstream of downstream movements of fish.
[43] Point of lowest elevation.

  - Collect water depth, velocity, and substrate data at longitudinal and cross-section survey points.

5) Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH within the riverine portion of the tributary. For comparison, measurements will be taken in three areas (within the Connecticut River near the mouth of the tributary confluence, within the affected portion of the tributary, and upstream of the influence of the normal water level fluctuations.
6) Photo document and delineate areas subject to fish stranding (*e.g.*, standing pools without or with little outflowing water to allow for volitional fish movements to deeper waters).

Backwater Areas – For purposes of this study we have defined backwater habitat as areas with a notable increase in water surface elevation caused by a constriction or obstruction in flow, or off-channel habitats created as a result of floodplain (or other habitat features, *e.g.*, oxbow) development. Backwater habitats are characterized by slow currents, shallow water, and silty or vegetated substrates. To assess the effects of Project operations, surveyors will locate backwater areas during relatively high water levels. Surveyors will collect/perform the following at each backwater site at these conditions:

1) Photo document and GPS the location of individual backwaters.
2) As possible, delineate the perimeter of backwatered areas with a sub-meter accuracy GPS. Aerial imagery may also be used to delineate backwater habitat.
3) Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH within the backwater. For comparison, measurements will also be taken in the impoundment near the backwater area.

Surveyors will then revisit backwatered areas during low water level conditions to assess connectivity and habitat conditions. The following information will be collected:

1) Photo documentation of backwaters at low water level conditions.
2) Photo documentation and GPS mapping of areas subject to fish stranding (*e.g.*, standing pools without or with little outflowing water to allow for volitional fish movements to deeper waters).
3) If barriers to fish movement are observed:
   - Record and photo document their location,
   - Perform longitudinal bathymetric/topographic thalweg survey of backwater area, with bed elevations relative to low water level elevation.
   - Collect water depth, velocity, and substrate data at longitudinal and cross-section survey points.
4) Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH within the backwater. For comparison, measurements will also be taken in the Connecticut River near the backwater area.

<u>Task 2: Evaluation of Fluctuation Range</u>

If it is determined that the existing flow fluctuation range creates barriers to fish movements in tributaries and/or backwatered areas, or adversely affects aquatic habitat, FirstLight will perform modeling/GIS studies to evaluate if changes in water level fluctuation range would mitigate for any identified impacts. Modeling software (*i.e.*, HEC-RAS or River 2D or comparable) will be used to develop a GIS to demonstrate changes in tributary or backwater access (including resultant water depth and water velocity modeling) at identified barriers and habitat conditions.

Task 3: Data Analysis and Reporting

Data will be compiled and analyzed after each sampling effort. Data will be developed in tabular and graphic format for inclusion in draft and final report preparation.

The report will be submitted as part of the Initial Study Report as per the ILP process schedule.

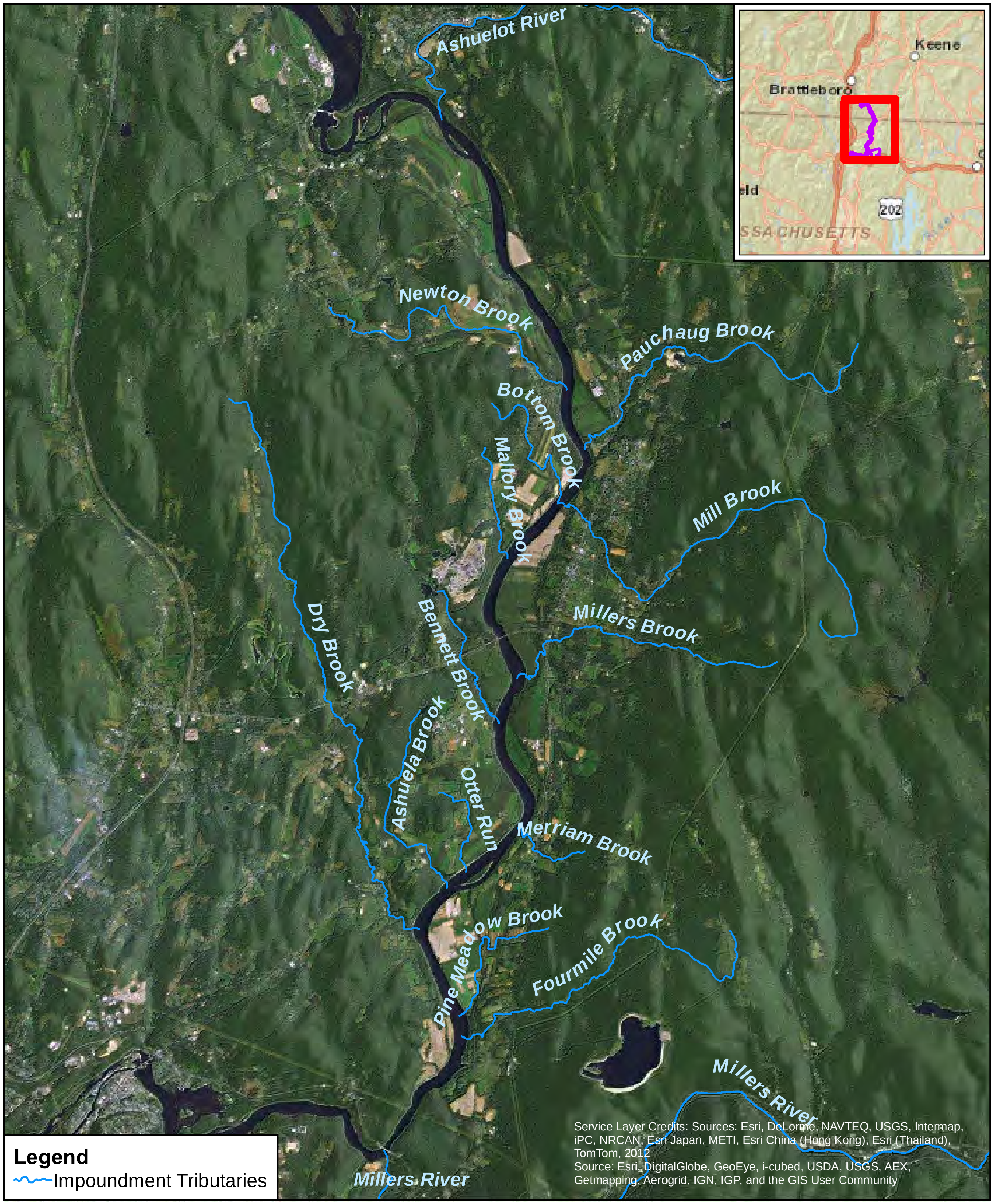
Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Turners Falls Project and Northfield Mountain Project on tributary and backwater access in the investigation area. The estimated cost for this one-year study is approximately $30,000 to $45,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

It is anticipated that this survey will be conducted in 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.



FirstLight Power Resources
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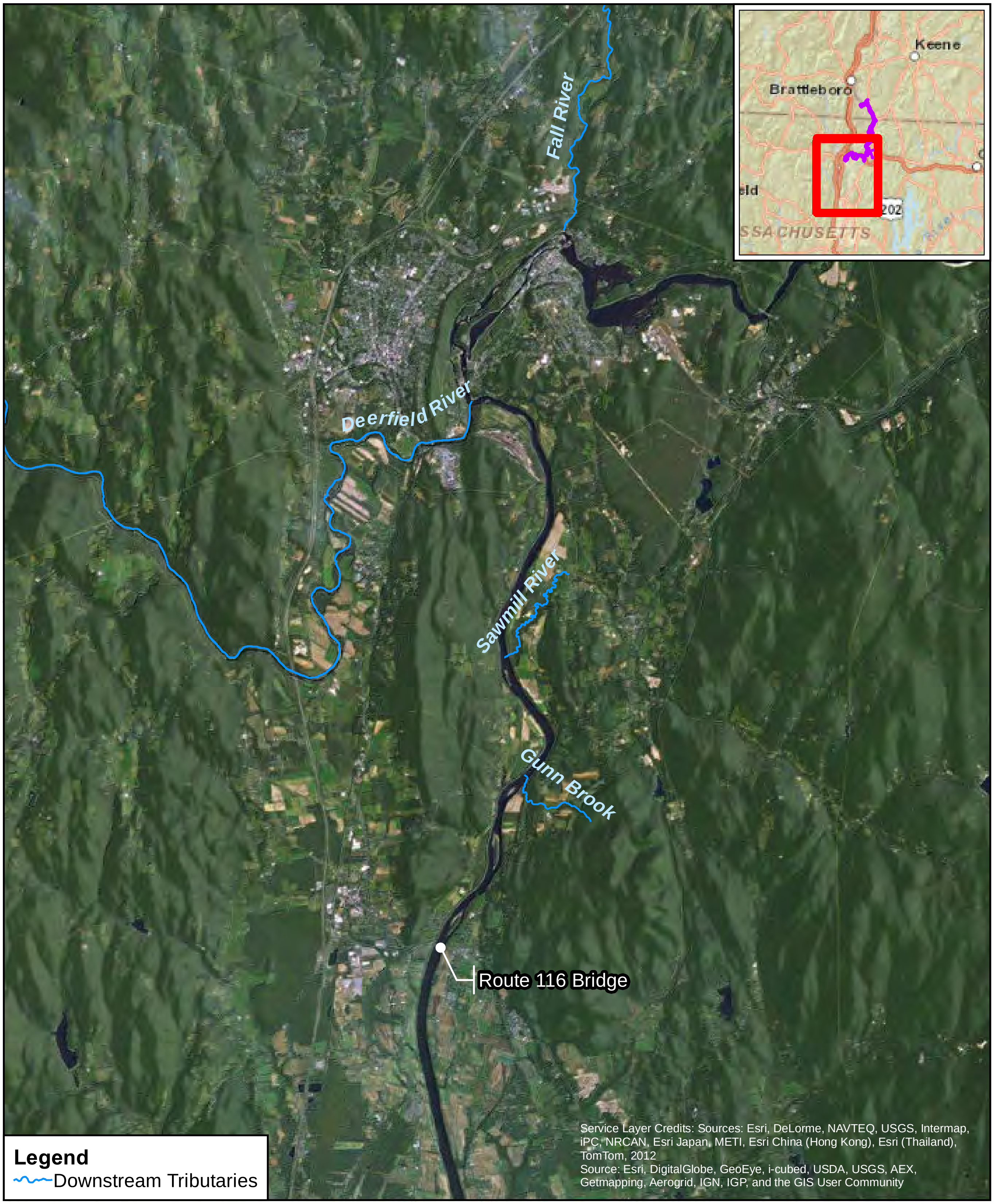
FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

0 1 2 4 Miles

Figure # 3.3.17-1
Location of Target Tributaries in the Turners Falls Impoundment for FirstLight's Tributary and Backwater Access Study

Path: W:\gis\maps\TributaryAccessStudy\TributaryList.mxd



FirstLight Power Resources
GDF SUEZ

FIRSTLIGHT POWER RESOURCES

PROPOSED STUDY PLAN

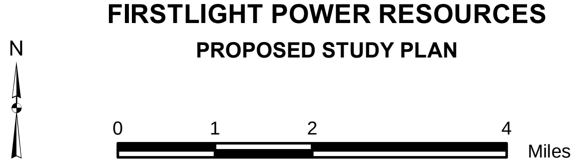


Figure # 3.3.17-2
Location of Target Tributaries Downstream of the Turners Falls Dam for FirstLight's Tributary and Backwater Access Study

Path: W:\gis\maps\TributaryAccessStudy\TributaryList_Downstream.mxd

3.3.18 Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms

General Description of Proposed Study

In the study request letter from the USFWS, a study to quantify the impacts of the annual Turners Falls Project canal drawdown on emigrating and resident fishes, freshwater mussels and mudpuppies in the canal was requested. Similar requests were also received from the MADFW, NHFGD, NOAA, CRWC, and TU. The stakeholder's indicate that the study request is intended to facilitate the collection of information necessary to conduct effect analyses and to develop reasonable and prudent conservation measures, along with PME measures.

Historically, FirstLight has conducted informal annual surveys of the canal during drawdown events. In 2011, a more extensive survey was conducted and documented in a memo report as explained below under the Existing Information discussion. FirstLight will conduct a similar survey during the 2014 drawdown event, with additional data collection aimed to fulfill the stakeholder's objectives as described below.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to identify and evaluate potential measures to reduce adverse effects due to dewatering for the annual canal drawdown events. The objectives are to:

- Assess whether juvenile shad and American eel abundance in the canal increases leading up to the time of its closure, due to delays in downstream passage (e.g., is fish accumulation occurring).
- Evaluate level of mortality for juvenile sea lamprey from exposure of burrow habitats in the canal.
- Conduct a survey of fish and aquatic organisms (e.g., freshwater mussels and mudpuppies) during the 2014 canal drawdown to document species presence, estimate relative densities, determine status (stranded, alive, dead), and map wetted areas.
- Evaluate measures to minimize aquatic organism population impacts of the canal drawdown.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The CRASC developed *A Management Plan for American Shad in the Connecticut River Basin* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The ASMFC Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, has the stated goal of "*Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats,*" and includes the following objectives:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

2. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g. turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The USFWS seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Turners Falls Project. General goals include the following:

1. Ensure that PME measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Turners Falls Project.

Specific to diadromous fishes, the USFWS goal is to minimize current and potential negative project operation effects on diadromous fishes, including juvenile shad, adult silver eels, and sea lamprey ammocetes.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Historically, FirstLight has observed stranding of juvenile American shad during annual canal drawdown events. In 2011, FirstLight's consultant and staff from Conte Lab conducted a more formal survey to include delineation of the canal into seven distinct zones. Each zone was visually surveyed for juvenile shad and other species, which were counted or estimated depending on numbers present. Any pool areas were documented with photos and represented on aerial photos. A summary report was developed and is provided in Appendix G of this PSP. While no shad were observed, probably because of a flood event prior to the drawdown, a variety of species were documented, including centrarchid and cyprinid species, sea lamprey, carp, perch, mussels, chain pickerel, and American eel. Numbers observed varied by zone and by species.

FirstLight anticipates conducting another survey of the dewatered canal in 2014 utilizing methods similar to those employed during the 2011 survey. Since information regarding the distribution and fate of juvenile sea lamprey in the canal remains unknown, additional efforts to fill this information gap will be included in the study plan for the 2014 drawdown event.

FirstLight believes that Study Nos. 3.3.4 and 3.3.5 will further address the concerns regarding whether outmigrating shad and American eels are impacted by the annual drawdown events.

Project Nexus (18 CFR § 5.11(d)(4))

Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations (where canal water level elevations are stable), downstream migrants are able to utilize the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station No. 1, unless the Cabot Station spill gates are utilized.

Once the canal has been drawn down, isolated shallow pools remain until the canal is refilled. During this period, fish (including lamprey ammocetes), amphibians, and benthic invertebrates are prone to desiccation, predation or other sources of mortality.

The annual canal drawdown was formerly conducted in July. In response to ISO-NE's request that FirstLight conduct the drawdown outside of the June through August period, FirstLight moved the drawdown to September, which coincides with the part of the migration period for some diadromous species.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

FirstLight believes that, with minor modifications, the 2011 survey methods are adequate to meet study objectives for documenting the species (fish, freshwater mussels, and mudpuppies) present in the canal during a drawdown event, estimating their relative densities, determining physical status (stranded, alive, dead), and developing a map of wetted areas. Additional efforts, described below, will be included to determine the level of mortality of juvenile sea lamprey due to exposure of burrowing habitat at the downstream end of the canal. Data collected during the 2014 canal drawdown event will be used to inform the selection of potential mitigation measures to be evaluated for minimizing the adverse effects of the drawdown events on aquatic organisms in 2015. FirstLight believes that Study Nos. 3.3.4 and 3.3.5 will address the concerns regarding whether outmigrating shad and American eels are impacted by the annual drawdown events.

Due to the iterative process of conducting survey methods that will be used by FirstLight and stakeholders to identify and evaluate potential mitigation measures, the Study Schedule section below identifies an estimated time line of activities to incorporate a consultation process into this study.

Task 1: Conduct Aquatic Organism Survey of Canal During 2014 Drawdown

Similar to the 2011 survey, the survey will be conducted by segmenting the canal into seven distinct zones (see map in Appendix G) and surveying each of the dewatered zones for observations of fish, mussels, and mudpuppies. The surveys will commence as soon as practicable after dewatering has been completed to avoid potential interference from avian predation of stranded fish. A field crew of experienced biologists will systematically traverse each of the zones recording observations of the types and estimated number of each species encountered. For each species observed, an assessment of the number of stranded, dead and alive individuals will be estimated. Additional information on the general location of species observations and predominant substrate type will be recorded on standardized field data sheets, as well as relevant weather conditions (air temperature, cloud cover estimate, precipitation, etc.).

Based on observations during previous drawdown events, leakage through the gatehouse and canal bathymetry allows the majority of Zone 7 to remain sufficiently wetted (see photos below). This leakage combined with the egress through the Keith Drainage Tunnel, appears to provide adequate flow and depth to support aquatic species over the short term. As such, the survey for aquatic organisms in Zone 7 will be focused on the exposed, higher elevation areas only.

Photos (taken during 2011 drawdown survey) depicting typical conditions in Zone 7 during canal drawdown event, and the Keith Drainage Tunnel.


Areas in Zones 2-4 (includes the areas of previous observations of juvenile sea lamprey) with appropriate soft sediment habitat will be further scrutinized to determine the distribution and relative abundance of juvenile sea lamprey (ammocetes) and mussels. Up to 10 randomly selected 1-m by 1-m quadrats will be sampled in each zone and counts of ammocetes and mussel by species will be recorded. The physical status (stranded, alive, dead) of the individuals will also be recorded. These data will be used to extrapolate counts for the entire area of suitable habitat within each zone.

The location of sufficiently wetted areas or pools will also be recorded for subsequent map generation (including Zone 7). Water quality parameters (temperature, dissolved oxygen, turbidity) will be also measured and recorded in the pools to inform the selection of potential mitigation measures in Task 2.

Task 2: Identify and Assess Potential Measures

This task will consist of consulting with agencies and other stakeholders to identify and evaluate potential measures that may reduce adverse effects on fish and mussels in the canal during drawdown conditions. Potential measures may include, but not be limited to, assessment of drawdown timing or placement of temporary weirs or baffles in select areas of the canal to enlarge pools that remain during drawdown events or create additional pools to keep specific habitat areas wetted for the duration of the drawdown event. The evaluation will compare the merits and drawbacks of each measure, as well as develop an order-of-magnitude cost estimate. Should FirstLight and stakeholders reach an agreement on appropriate measure(s) to evaluate in the field then engineering design will proceed in Task 3.

Task 3: Design Selected Measure(s)

Upon agreement between FirstLight and stakeholders on appropriate measure(s), if any, to reduce adverse effects on aquatic organisms during drawdown events, engineering design (if applicable) of the selected measure(s) will be developed in consultation with Stakeholders in 2015.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to conduct a drawdown survey and design potential measures, if feasible, to reduce the impacts of the annual drawdown events on aquatic organisms present in the canal. The total estimated cost for the proposed study is approximately $35,000 - $55,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

- FirstLight to conduct Task 1 field surveys – September 2014
- Distribute summary report of results Task 1 and initial list of potential measures to be evaluated under Task 2 – January 2015
- Hold meeting with Stakeholders to review Task 1 summary, seek to reach consensus on measure(s) to be field evaluated, and metrics for determining relative success of measure(s) to reduce effects of drawdowns – February – March 2015
- Prepare conceptual design, if applicable, of measure(s) to be evaluated and submit to Stakeholders for review – April – May 2015
- Finalize conceptual design in consultation with Stakeholders, including meetings as determined appropriate – June 2015
- Construct test materials for placement and testing – July – August 2015
- Install– September 2015
- Distribute summary report of 2015 results for Stakeholder review – January 2016
- Hold meeting with Stakeholders to review results of testing and conclusions – February – March 2016

3.3.19 Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace

General Description of Proposed Study

An evaluation of the use of an ultrasound array to keep shad out of the Cabot Station tailrace and facilitate upstream movement of American shad to Turners Falls Dam was requested by USFWS, NHFG and CRWC. This study will be conducted in 2015 pending the results of Study No 3.3.1 and Study No. 3.3.2, which include analysis of historic fish passage data.

The location of the proposed array would be in the area of the identified shortnose sturgeon spawning grounds. It would need to be operated during the sturgeon spawning season as the shad upstream migration and sturgeon spawning periods overlap.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine if an ultrasound barrier could be used to repel adult shad from the Cabot Station tailrace and guide them into the bypass reach.

The objective of the study would be to establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream migrating radio-tagged shad moving past Cabot Station. This would be accomplished by monitoring the movements and passage of shad and the time shad spend in the tailrace area.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

In 1992, the Connecticut River Atlantic Salmon Commission (CRASC) developed a draft document titled: *A Management Plan for American Shad in the Connecticut River Basin*.

Management Objectives in the plan include the following:

Specific management objectives in the plan include the following: Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually; achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem; and maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes and objective to maximize the number of juvenile recruits emigrating from freshwater stock complexes.

Amendment 3 also includes the following recommendations for upstream passage:

- American shad must be able to locate and enter the passage facility with little effort and without stress.
- Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.

- Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In spite of the extensive studies and many successes for some species of fish at some station intakes, as yet there is no one behavioral barrier or deterrent that is effective with all species and lifestages of fish. Behavioral barriers are generally still considered experimental.

High frequency sound was used at the James A. Fitzpatrick power plant located on Lake Ontario, and was found to reduce impingement of alewife by more than 80 percent and its use was approved by the regulatory agencies. Similar avoidance by herring species was noted where sound was tested at hydroelectric sites.

American shad and alewife belong to the same family, Clupeidae, and their reaction to high frequency sound may be similar. Information exists about adult shad avoidance of ultrasound. In field trials in the early 1980s to develop a guidance system for downstream-migrants in the First Level Canal of the Holyoke Canal System, adult shad avoided but were not well guided by an ultrasonic array. However, upstream migrants were guided well and even stopped entirely by the ensonified field (Kynard and Taylor, 1984). Creating an ensonified field caused adult shad to leave their preferred location in the river upstream of trashracks at Holyoke Dam as long as the sound system was on.

Blueback herring also avoided the ultrasound field and behaved similar to shad in the Holyoke Canal studies (Kynard and Taylor, 1984). Acoustic barriers have been used for blueback herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina and on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). Evidence from many studies that attempted to produce behavioral avoidance by adult shad suggests that ultrasound is an effective stimulus (Carlson and Popper, 1997). Evidence suggests that shad and blueback herring may avoid the tailrace of Cabot Station if an ultrasound field was installed; however, simply repelling shad from the Cabot tailrace is not a satisfactory result, for this behavioral barrier to be successful the fish would also have to keep going upstream, without delay, as opposed to dropping down below Cabot.

Project Nexus (18 CFR § 5.11(d)(4))

Studies to assess potential passage solutions are frequently conducted during relicensing proceedings. This study, coupled with the adult shad radio-telemetry study, can provide the information needed to select an approach to resolve upstream shad passage at the Turners Falls Project.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Ultrasound Deployment

This study would establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream migrating shad moving by Cabot Station by monitoring shad behavior. Telemetry methods like those proposed in Study No. 3.3.2 will be utilized. FirstLight will consult with the agencies to determine a schedule to turn the array off and on.

Task 2: Reporting

Data collected in Task 1 will be analyzed to determine if ensonification is a successful guidance mechanism. A report will be prepared detailing methods, results, a discussion and conclusions.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The cost for the test would be $55,000 to $70,000. Costs will be related to rental, installation, and operation of the ultrasound system, analysis of data, and production of a final report. The study could utilize the same monitoring equipment as the adult shad radio telemetry study (although a few additional tracking stations may have to be installed in the Cabot Station tailrace).

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The study proposed herein will be conducted in the second study season, after the adult shad study described in Study No. 3.3.2, *Evaluate Upstream and Downstream Passage of Adult American Shad*, if, following completion of that study, additional data are required to evaluate the upstream passage of American shad past Cabot Station. American shad migrate up the river when water temperatures are generally between 12 and 20°C; spawning occurs from 14 to 23°C when river flow is generally declining from the spring peak with shad reaching Cabot Station in late April or early to mid- May. The ultrasonic array and shad monitoring equipment will be deployed, calibrated and tested in late March and early April, prior to the arrival of adult shad to the study area. If performed, the study is anticipated to conclude by mid-July 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

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3.4 Terrestrial Wildlife and Botanical Resources

3.4.1 Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, the Bypass Reach and below Cabot Station within the Project Boundary

General Description of Proposed Study

In its PAD, FirstLight proposed to conduct a study to obtain baseline information on terrestrial wildlife and botanical resources in the Turners Falls Impoundment, the Bypass Reach, and below Cabot Station within the Project boundary. The Town of Montague, MA requested that FirstLight complete a wildlife habitat assessment of the Turners Falls Bypass.

Note that terrestrial resources around the Northfield Mountain Project are being studied, as described in Study No. 3.4.2.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to characterize and describe the terrestrial wildlife and botanical resources that use representative upland habitats within the Project boundary. Specific objectives are:

- Survey and inventory overall existing upland wildlife habitats;
- Note the occurrence of wildlife sighting during the course of the surveys;
- Survey and inventory vegetation cover classes and land use;
- Survey and evaluate the presence of targeted RTE species or associated habitats; and
- Survey and inventory the nature and extent of upland invasive and exotic vegetation species.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study plan will provide baseline information to agencies with jurisdiction over wildlife and botanical resources allowing them to address potential Project effects. Resource management goals relevant to terrestrial wildlife and botanical resources studies are described below.

Terrestrial wildlife resources are administered by the USFWS. The mission of the USFWS is to "conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people." In doing so, USFWS enforces wildlife laws, protects endangered species, manages migratory birds, and helps to restore important fisheries. They administer the ESA, designed to protect imperiled species from going extinct.

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program (NHESP) of the MADFW. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions and protection of wetlands and aquatic habitats of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The MADFW's resource goals and regulatory requirements are to:

- Ensure that protection mitigation and enhancement measures are commensurate with Project effects and meet MESA and the WPA requirements for the Project.

- Conserve, protect, and enhance habitats for state-listed species that will be affected by Project operations.

Massachusetts Invasive Plant Advisory Group (MIPAG) maintains a list of invasive plant species in Massachusetts and provides criteria used in evaluating species. The NHESP management goal is to promote the conservation and protection of species that are not hunted, fished, trapped or commercially harvested in Massachusetts. The NHESP highest priority is protecting the state listed RTE species. The overall goal of the program is the protection of the state's wide range of native biological diversity.

The conservation goals of the VDFW are to:

- Maintain or increase populations of rare, threatened and endangered species in the area of interests;

- Maintain, restore, provide long-term stewardship of, or conserve habitats and natural communities that support rare, threatened and endangered species.

NHFG primary management goals relative to terrestrial and wildlife resources are to restore and maintain critical habitats and populations of the state's species of conservation and management concern.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

The PAD provides a list of plant and wildlife species, as well as dominant vegetative communities in the Project area, but does not provide any site-specific information on the known occurrences of species within the upland habitats of the Project. Additional site-specific data are needed to meet the goal of evaluating Project effects. Studies will supplement existing information regarding vegetation mapping, invasive plants, and presence of RTE species or associated habitat.

In preparation of the PAD, Federal and state agencies were contacted regarding the potential presence of RTE species and critical habitats within the Turners Falls Project and Northfield Mountain Project boundaries and included the USFWS, NMFS, Massachusetts NHESP, VTFWD, and NHFGD. The consultation resulted in the identification of three federally-listed threatened and/or endangered species (Section 4.7.1 of the PAD), 39 state-listed threatened and/or endangered species (Section 4.7.2 of the PAD), 21 state-listed species of special concern (Section 4.7.3 of the PAD) and designated critical habitat (Sections 4.7.4) that are likely or known to occur within the Project boundary and are detailed in Section 4.7 of the PAD.

Agency consultation revealed no federally designated critical habitat areas within the Turners Falls Project and Northfield Mountain Project areas; however, the Project areas maybe located within or on a portion of State designated Natural Areas classified as priority habitats and/or estimated habitats. Detailed information regarding habitat preferences and life histories of these species can be found in Section 4.7 of the PAD.

Project Nexus (18 CFR § 5.11(d)(4))

The Turners Falls Project and Northfield Mountain Project provide habitat for a variety of wildlife and botanical species. Water levels fluctuations have the potential to affect habitat for a variety of life stages of terrestrial species. An understanding of the terrestrial resources in the project area would provide information on the type and quantity of habitat potentially affected by Project operations.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

A field survey of the shoreline will be conducted within the Turners Falls Impoundment, in the Bypass Reach, and below Cabot Station to the downstream extent of the Project boundary to document the type and distribution of wildlife habitats, including vegetation communities and plant species, present in the project area. A field survey of wildlife species will be conducted concurrently with other botanical and wetland studies (Study No. 3.5.1). Surveys will be conducted by biologists visually assessing habitats along and above the shoreline from boat and/or walking on FirstLight and public lands during the growing season when vegetation is most conspicuous and readily identifiable. FirstLight will seek permission from adjacent land owners to gain access to privately owned lands that are within the survey area. The presence of any RTE species or habitats will also be noted. Observations of RTE species documented in the Project area will be processed in accordance with applicable State and Federal procedures and all data and records will be available immediately to appropriate organizations (USFWS, MADFW).

Task 1: Literature Review

The initial step prior to the field reconnaissance surveys will include reviewing existing information and data to identify areas of representative communities and potentially suitable habitat for protected species of interest. Using GIS and other available sources of information, a preliminary base map will be produced to assist field surveys. To refine the vegetation and habitat mapping for the study area, the following tasks will be performed:

- Acquire and compile existing GIS vegetation cover type layers from available resources;
- Examine any visible vegetation boundaries in aerial photos or other imagery to fix or update type polygon boundaries, based on field observations;
- Produce a final vegetation type map that displays vegetation type polygon boundaries, the study area, and specific Project components; and
- Use the vegetation type map to produce a table of vegetation types and calculate the percent acres of each vegetation type present in the study area, in areas potentially affected by the Project, and indirectly affected key wildlife habitats.

Task 2: Field Surveys

Field surveys will be conducted to document wildlife habitat and occurrence, vegetative cover types and invasive plant species in the Project area, as described below.

Wildlife and Habitat Type Mapping

The primary objective of wildlife surveys for the Project is to provide information on the distribution and abundance of wildlife habitats. General habitat field notes will record dominant vegetation cover classes and land use; habitat types; observations of avian, reptile, amphibian, and mammal species; and locations of upland invasive plant species. Wildlife surveys will be conducted through the use of visual encounter surveys concurrent with the habitat type verification mapping.

Transect lines parallel to the shoreline will be placed randomly or at least objectively with respect to representative habitats present along the shoreline of the study area. The total number of transects will be determined after an initial site reconnaissance and completion of the preliminary GIS base mapping. One transect will be completed for each representative habitat type. The observer will walk a transect at a pace of approximately five minutes per 50 meters, for a total search time of up to approximately two hours.

The transect width will be line-of-sight. During these transect searches, an observer will survey the area to either side of the transect, looking for targeted species or indirect signs (i.e., tracks, scat, den areas, nests, etc.) To account for the seasonal variability of wildlife and varying flowering periods when plants are most readily identifiable, for each habitat transect a presurvey review of fauna and flora likely to occur in each specific habitat identified by the GIS base mapping phase of the study, will research life-histories and plant phenology for identifying survey windows in the season when transect observations should be completed to optimize the likelihood of noting occurrences. The survey period will be from March 2014 through August 2014 and each transect will be surveyed only once, however, qualitative data from other similar surveys efforts will also be noted and included in the overall wildlife census list.

No unique natural communities have been documented by the NHESP within the Turners Falls Project and Northfield Mountain Project area. Unique natural areas are habitats that support or may support, state listed species that are identified by the NHESP as priority habitats. NHESP maintains mappings of these identified areas in the Massachusetts Natural Heritage Atlas 13th Edition.

The NHESP tracks examples of communities that are state ranked (SRank) to reflect a habitat community's rarity and threat within the region and in Massachusetts. A NHESP review of the project resulted in no site specific examples of known natural communities that demonstrate regional rarity and are threatened. Generally, preliminary review of the natural communities were identified as being located in the Turners Falls Project and Northfield Mountain Project area had a SRank value of S4 and S5, which are defined and categorized by NHESP as apparently (S4) to demonstrably (S5) secure in Massachusetts. In addition, a review of the USFWS Environmental Conservation Online System database lists no federally designated critical habitat areas in the Turners Falls Project and Northfield Mountain Project area.

While completing field surveys, if a priority habitat is located or a natural community is noted as having a state ranking of S3, S2, or S1 (Community types that are range from vulnerable S3, imperiled S2 or critically imperiled S1, due to rarity /vulnerability to extirpation) or natural areas where observed federal or state listed species occur, more intensive searches will be performed. Other supplemental techniques, such as broadcast or listening surveys will be used to improve the odds of detecting some more elusive avian and amphibian species. The locations of significant sightings or observations (i.e. bald eagle, or peregrine falcon nests) will be documented through the use of GPS and geo-referenced photographs and then entered into the GIS data base. Data collected will be compiled into a Project area species list.

Bald eagles have been documented nesting on Barton Island in Barton's Cove, approximately five miles downstream of the Northfield Mountain Project and slightly upstream of the Turners Falls Dam. Bald eagles also nest on Kidd's Island in the impoundment, and are known to perch in riverbank trees and forage over the Connecticut River in the Project Area. In addition to an overall impoundment survey to document the occurrence of any bald eagle nesting sites, the above known areas will be surveyed to confirm the presence or absence of any nesting sites or direct observations of bald eagles. Where encountered, bald eagle nests will be GPS located and photo-documented.

Vegetation Cover Type Mapping

The overall design of the vegetative mapping is to identify all vascular botanical species within the Study Area while focusing on targeted listed species and other RTE plant species as identified during consultation with the NHESP. Botanical assessments will be completed to determine the species composition, structure, and distribution of vegetative communities. The types of data that will be collected within habitat types include percent cover and dominant species within the herbaceous, shrub, and tree stratums, along with the general distribution and juxtaposition of vegetative communities.

Timed-meander surveys will be conducted in representative habitat types encountered within the Study Area. The meander survey will involve walking a wandering path through each habitat and recording species present until a period of time (typically for approximately ten minutes) passes where no new species are added to the vegetation list. Surveyors will compile a list of all plants found within each respective habitat, and will also maintain an overall census list of all plant species identified within the Project Area. Plants will be identified to the species level if possible, or at a minimum, if the plant is outside its phenological peak, the plant will be identified to the genus level if species identification is not possible. If positive identification cannot be completed in the field, a voucher sample may be collected, pressed, and preserved for further identification when appropriate.

Prior to the 2014 field survey, biologists will obtain the necessary collecting permit for any voucher samples that may need to be collected from the State Botanist at the Massachusetts NHESP. Biologists will also coordinate with VDFW and NHFG RTE programs if similar collection permits are required for voucher samples prior to any field studies. Other general information that will be gathered during meander surveys will include general health of communities and site quality conditions. Vegetation communities will be classified using the NHESP Classification of the Natural Communities of Massachusetts (Swain & Kersey, 2011).

Sample vegetation plots will also be established in each representative habitat type to collect quantitative information to characterize the different habitats and provide species composition of habitat types. Vegetation plot locations will be selected using NHESP guidelines and protocols. A NHESP Quantitative Community Characterization Form (NHESP Form 3) will be completed for representative habitats to document the results of each plot location. Geo-referenced photographs will also be taken to document site conditions at the time of the survey.

Invasive Plant Survey

The MIPAG maintains a list of 34 noted invasive plant species occurring in Massachusetts and provides criteria used in evaluating species. Invasive plants as defined by the MIPAG are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. Of the 34 plants listed by the MIPAG, a total of 24 invasive species have been identified as having the potential to occur in the Study Area. Invasive plants identified by the MIPAG not included in this study were omitted based on regional occurrence (i.e., occur in coastal areas) or occur in aquatic habitats, which are addressed as part of Study No. 3.5.1. A list of upland invasive plant species with the potential to occur in the Study Area is provided in Table 3.4.1-1.

Table 3.4.1-1: Upland Invasive Plant Species.

Scientific Name	Common Name	Lifeform Type	Notes
Acer platanoides	Norway maple	Tree	Common in woodlands with colluvial soils, grows full sun to full shade dispersed by water, wind and vehicles
Aegopodium podagraria	Bishop's weed	Perennial Herb	Occurs both in uplands and wetlands. Grows in full sun to full shade, spreads aggressively by roots; forms dense colonies in flood plains
Ailanthus altissima	Tree of heaven	Tree	Occurs in uplands, wetlands, grows in full sun to shade. Spreads from root suckers, especially in disturbed areas
Alliaria petiolata	Garlic mustard	Biennial Herb	Widespread, grows full sun to full shade, spreads by seed, especially in wooded areas
Berberis thunbergii	Japanese barberry	Shrub	Wooded uplands and wetlands, grows in full sun to full shade, spread by birds, forms dense stands
Celastrus orbiculatus	Oriental bittersweet	Perennial vine	Grows in full sun to partial shade, berries spread by birds and humans
Cynanchum louiseae	Black swallow-wort	Perennial vine	Grows in full sun to partial shade, forms dense stands, deadly to Monarch butterflies
Elaeagnus umbellata	Autumn olive	Shrub	Grows in full sun, berries spread by birds, aggressive in open areas
Euphorbia esula	Leafy spurge	Perennial herb	Occurs in grasslands
Frangula alnus	Glossy buckthorn	Shrub -Tree	Occurs in uplands and wetlands, grows in full sun to full shade, forms thickets
Hesperis matronalis	Dame's rocket	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, spreads by seed, can form dense stands in flood plains
Lonicera japonica	Japanese honeysuckle	Perennial vine	Widespread, grows full sun to full shade, climbs vegetation, seeds dispersed by birds
Lonicera morrowii	Morrow's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Lonicera x bella	Bell's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Polygonum cuspidatum	Japanese knotweed	Perennial Herb-subshrub	Widespread, grows in full sun to full shade, spreads vegetatively and by seed, forms dense thickets

Scientific Name	Common Name	Lifeform Type	Notes
Lysimachia nummularia	Creeping jenny	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, forms dense mats
Lythrum salicaria	Purple loosestrife	Perennial herb	Occurs in uplands and wetlands, grows in full sun to partial shade, high seed production, overtakes wetlands
Phalaris arundinacea	Reed canary grass	Perennial grass	Occurs in uplands and wetlands, grows full sun to partial shade, can form large colonies, common in agricultural settings
Phragmities australis	Common reed	Perennial grass	Grows in uplands and wetlands, full sun to full shade, forms dense stands, flourishes in disturbed areas
Polygonum perfoliatum	Mile-a-minute	Annual vine	Found along fields and road edges in full sun to partial shade, bird and human dispersed
Ranunculus ficaria	Lesser celandine	Perennial herb	Occurs in lowland and upland woods, grows in full sun to full shade, spreads vegetatively and by seed, forms dense stands
Rhamnus cathartica	Common buckthorn	Shrub-tree	Occurs in uplands and wetlands, grows in full sun to full shade.
Robinia pseudoacacia	Black locust	Tree	Occurs in uplands, grows full sun to full shade, aggressive in areas with sandy soils
Rosa multiflora	Multiflora rose	Shrub	Widespread, grows in full sun to full shade, forms thorny thickets, dispersed by birds.

The MIPAG list of invasive plant species provided in Table 3.4.1-1 will be utilized to identify upland invasive species when conducting botanical meander surveys. Surveyors will use methods adapted from the USFS Invasive Species Program, Invasive Species Inventory and Mapping Data Recording Protocols. These adapted methods focus on presence, location, extent, abundance and other site characteristics to provide site infestation information.

The intent of the upland invasive species survey is to document significant infested areas. Biologists will use GPS at sub-foot accuracy to delineate the boundary of the infestation as defined by the dominant canopy cover of the invasive plant. Lesser areas containing only occasional invasive species will be characterized with a GPS center point and radius necessary to enclose the population will be used. For areas where invasive species are ubiquitous or impractical to map, surveyors will characterize the invasive species population using estimates of aerial coverage and percent of species present. For areas where dense stands of upland invasive species have formed, infestations will be photo-documented and geo-referenced, and an Invasive Species Documentation Form will be completed.

Task 3: Data Analysis and Reporting

A draft and final technical report will be prepared for this study. The results of this study will provide both quantitative and qualitative information that will be important in defining existing conditions, as well as providing any information on potential project impacts. The report will contain all supporting correspondence among licensing participants. The draft report will be revised to address final comments by licensing participants.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

This study would likely take one study season to complete. The estimated budget for the study ranges from approximately $60,000 to $80,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

This study will be conducted as follows:

- January – March 2014: Reviewing existing information and data
- March - August 2014: Conduct field reconnaissance surveys
- September - December 2014: Prepare data and report

Literature Cited

Swain, P.C., & Kersey, J.B. (2011). Classification of the Natural Communities of Massachusetts: Draft. Retrieved from http://www.mass.gov/dfwele/dfw/nhesp/natural_communities/natural_community_classification.htm. Accessed August 23, 2011.

3.4.2 Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats

General Description of Proposed Study

FERC requested FirstLight to complete a study to provide baseline information on wildlife and botanical habitats occurring in the Northfield Mountain Project area, and study the effects of Northfield Mountain Project-related land management practices and recreation use on terrestrial habitats.

FirstLight is proposing a study to collect baseline information, which will inform an assessment of Project-related land management practices and recreational use impacts on terrestrial resources on Project lands at the Northfield Mountain Project.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to gather information necessary to understand the potential effects of land management practices and recreational use on wildlife and botanical resources within the Northfield Mountain Project area. The objectives of this study are to provide supporting information which will provide the basis for an assessment of the potential resource impacts of the Project that were identified during development of the PAD and FERC scoping for the License Application, as follows:

- Identify and describe FirstLight's Project-related land management practices (including the maintenance of Project-related recreation areas) occurring in the Northfield Mountain Project boundary;
- Provide information pertinent to describe existing wildlife and botanical habitats occurring in the Northfield Mountain Project area;
- Determine if Project-related land management and maintenance practices and the use of Project-related recreation areas has the potential to facilitate the growth and spread of invasive plant species; and
- Provide information to identify if Project-related land management and maintenance practices and the use of Project-related recreation areas may affect existing wildlife and botanical resources (e.g., clearing of vegetation, erosion from recreational activities).

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study plan will provide baseline information to agencies with jurisdiction over wildlife and botanical resources allowing them to address potential Project-related effects. The Connecticut River watershed supports a diverse assemblage of plant and wildlife communities that provide various public opportunities, such as bird watching, hiking, and hunting. Consideration of the effects of Project operations, maintenance, land management, and recreational use on these resources is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

The PAD provides baseline information pertaining to the effects of project operation, maintenance, land management, and recreation use on wildlife and botanical habitats and the location of invasive plant species within the Northfield Mountain Project area. FirstLight is proposing to conduct wildlife and botanical studies for the Turners Falls Project as outlined in Study No. 3.4.1 and Study No. 3.5.1; however, those studies only address the Turners Falls Impoundment (lower reservoir for the Northfield Mountain Project) and downstream areas with a focus on assessing Project operations primarily associated with water level fluctuations. Additional information on the location and abundance of invasive plant species and the impacts on wildlife and botanical resources as a result of project-related maintenance and land management practices in the Northfield Mountain Project area are needed to evaluate the Project's full effects on wildlife and botanical resources.

In 2006, FirstLight, formerly operating under the NE Hydro Generating Company name, contracted Tighe & Bond, Inc. to complete a botanical survey on Project lands where land management and recreational activities occurred. The areas surveyed included Bennett Meadow Wildlife Management Area, Barton Cove Campground and a Picnic Area on the Turners Falls Impoundment. The summary report describes the survey efforts that focused on the lower impoundment, which provides insight as to which species are within those areas surveyed and what could potentially be at other sites within the Northfield Mountain Project boundary. In the MADFW review letter dated April 25, 2007 from the MADFW to Tighe & Bond (NHESP Tracking Number: 06-19884), the MADFW indicated that the Northfield Mountain Recreational Trails are not located within Priority Habitat or Estimated Habitat and concluded that existing uses of the recreational facilities described in the Operation and Maintenance Plan would not require review under the MESA; however, select activities which are regulated by FERC licenses may require review by NHESP during the FERC review process.

FirstLight conducted a recreational facilities inventory at the Turners Falls Project and Northfield Mountain Project during two field visits in October 2011 and July 2012 (see Study No. 3.6.2). The purpose of the inventory was to identify the current formal recreational facilities associated with the Projects. This information was needed to prepare the recreation sections of the PAD. TRC developed a report (2012) of these facilities providing a summary of each formal recreational facility that was inventoried. This report will be used as baseline information as to what types of recreational use could potentially affect wildlife and botanical habitats at the Northfield Mountain Project.

Project Nexus (18 CFR § 5.11(d)(4))

The Northfield Mountain Project provides habitat for a variety of wildlife and botanical species. An understanding of the terrestrial resources in the Project area would provide information on the type and quantity and quality of habitat potentially affected by Project-related land management and maintenance practices and the use of recreational areas.

The Northfield Mountain Project has many recreational features (e.g., a trail system with over 26 miles of trails, observation area, picnic areas) that are inherently attractive. Public recreation sites can affect wildlife behavior (both attracting and displacing) and impact botanical resources (e.g., trampling of vegetation, erosion along trails and spreading invasive species). An analysis of the effects of the maintenance, land management practices, and use of these recreational features on wildlife and botanical resources would help form the basis for determining the Project's effect on these resources.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

For the purposes of this study, the Northfield Mountain Project area includes the lands around Project facilities (e.g., lands around the upper reservoir, parking areas, access roads) and recreational areas (e.g., picnic areas, trails, and hiking areas) on Northfield Mountain.

A field survey of wildlife and botanical species will be conducted concurrently with other field surveys where applicable. Wildlife and botanical resource assessments will be conducted on the terrestrial, wetland, riparian, and littoral areas of the Turners Falls Impoundment, bypass and downstream areas as described in Study No. 3.4.1 and Study No. 3.5.1. Surveys will be conducted by biologists during the 2014 growing season.

Task 1: Literature Review

A pre-survey review of existing information and data will be completed to identify areas of representative communities, land use classes, recreational areas and trails, invasive species and potentially suitable habitat for protected species of interest as identified in Section 4.7 of the PAD. Using GIS and other available sources of information, a preliminary field map will be produced to assist field surveys.

Prior to field investigations, researchers and biologists will review and screen the practices and locations of FirstLight Project-related land use management activities (e.g., areas routinely mowed, vegetation management areas, access roads), and recreational uses (e.g., trails, climbing areas, camping, skiing) at the Northfield Mountain Project.

Task 2: Wildlife and Habitat Type Mapping

The primary objective of wildlife surveys for the Northfield Mountain Project is to provide a general census and information on the distribution and abundance of wildlife habitats. General habitat field notes will record dominate vegetation cover classes; unique or unusual habitat types; and observations of avian, reptile, amphibian, and mammal species. Wildlife surveys will be conducted through the use of visual encounter surveys along transects.

Transect lines will be placed randomly or at least objectively with respect to representative habitats, including representative Project-affected habitats (i.e., areas of vegetation management, recreational use areas). Transects will include non-impacted areas and impacted areas for comparison. The total number of transects will be determined after an initial site reconnaissance in early spring. The observer will walk a transect at a pace of approximately five minutes per 50 meters, for a total search time of up to approximately two hours. The transect width will generally be line-of-sight. During transect searches, an observer will survey the area to either side of the transect, looking for targeted species or indirect signs (i.e., tracks, scat, den areas, nests, etc.).

To account for the seasonal variability of wildlife and varying flowering periods when plants are most readily identifiable, for each habitat transect a presurvey review of fauna and flora likely occurring in each specific habitat identified during the GIS base mapping phase of the study, FirstLight will research life-histories and plant phenology for identifying survey windows in the season when transect observations should be completed to optimize the likelihood of noting occurrences. The survey period will start in March 2014 and extend to the end of August 2014. Transects will be surveyed only once per season, however, qualitative data from other similar surveys efforts will also be noted and included in a overall wildlife census list.

The NHESP tracks examples of priority habitats and types of natural communities that are state ranked (SRank) to reflect the community's rarity and threat within the region and in Massachusetts. Generally, preliminary review of the natural communities were identified as being located in the Turners Falls Project and Northfield Mountain Project area had a SRank value of S4 and S5, which are defined and categorized by NHESP as apparently (S4) to demonstrably (S5) secure in Massachusetts. No priority habitats or rare natural communities have been documented by NHESP within the Turners Falls Project and Northfield Mountain Project area. In addition, a review of the USFWS Environmental Conservation Online System database lists no federally designated critical habitat areas in the Turners Falls Project and Northfield Mountain Project area.

While completing field surveys if a priority habitat is located or a natural community noted as having a state ranking of S3, S2, or S1 (community types that are range from vulnerable, imperiled or critically imperiled, due to rarity /vulnerability to extirpation), or natural areas where observed federal or state listed species occur more intensive searches will be performed. Other supplemental techniques, such as broadcast or listening surveys will be used to improve the odds of detecting some more elusive avian and amphibian species. Field studies will be conducted on a seasonal basis in order to record species when they are most conspicuous. The locations of significant sightings or observations will be documented through the use of GPS and geo-referenced photographs and then entered into a GIS data base. Data collected will be compiled into a Project area species list.

Task 3: Vegetation Cover Type Mapping

Botanical assessments will be completed to determine the species composition, structure, and distribution of vegetative communities. The types of data that will be collected include percent cover and dominate species within the herbaceous, shrub, and tree stratums along with the general distribution and juxtaposition of vegetative communities. Timed-meander surveys will involve walking a wandering path through each representative habitat type and recording species present until a period of time (usually 10 minutes) passes where no new species were added to the vegetation list. Surveyors will compile a list of all plants found within each respective habitat, and will maintain a list of all plant species identified within the Project Area.

Plants will be identified to the species level if possible, or at a minimum, if the plant is outside its phenological peak, the plant will be identified to the genus level if species identification is not possible. If positive identification cannot be completed in the field, voucher samples can be collected, pressed, and preserved for further identification when appropriate. Prior to the 2014 field survey, biologists will obtain the necessary collecting permit for any voucher samples that may need to be collected from the State Botanist at the Massachusetts NHESP. Other general information that will be gathered during meander surveys will include general health of communities, evidence of erosion, and site quality conditions. Vegetation communities will be classified using NHESP Classification of the Natural Communities of Massachusetts (Swain & Kersey, 2011).

Palustrine habitats will be field-verified using the NWI as a base map. These areas will not be formally delineated, but will be further defined from the existing NWI maps and if applicable expanded to add a better level of detail to the wetlands extent. When observed Non-NWI mapped wetlands will also be located using methods outlined in the ACOE Wetland Delineation Manual and the Regional Supplement to the *Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region* (USACE, 1987; USACE, 2012).

Sample vegetation plots within representative habitat types will also be established to collect quantitative information to characterize the different habitats and provide species composition of habitat types. Vegetation plot locations will be selected using NHESP guidelines and protocols. Sample vegetation plots will be completed for representative areas of Project-related vegetation management and recreational areas. These plots will be used to compare natural undisturbed habitats at the Projects to Project-affected habitats. A NHESP Quantitative Community Characterization Form (NHESP Form 3) will be completed for representative habitats to document the results of each plot location. Geo-referenced photographs will also be taken to document site conditions at the time of the survey.

To refine the vegetation type map for the study area, the following tasks will be performed:

- Acquire and compile existing GIS vegetation cover type, land use, and recreational layers from available resources;
- Examine any visible vegetation boundaries in aerial photos or other imagery to fix or update type polygon boundaries, based on field observations;

- Produce a final vegetation type map that displays vegetation type polygon boundaries, the study area, and specific Project components; and
- Use the vegetation type map to produce a table of vegetation types and calculate the percent acres of each vegetation type present in the study area in general, in areas potentially affected by the Project, and indirectly affected key wildlife habitats.

Task 4: Invasive Plant Survey

The MIPAG maintains a list of 34 noted invasive plant species occurring in Massachusetts and provides criteria used in evaluating species. Invasive plants as defined by the MIPAG are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. Of the 34 plants listed by the MIPAG, a total of 24 invasive species have been identified as having the potential to occur in the Study Area. Invasive plants identified by the MIPAG not included in this study were omitted based on regional occurrence (i.e., occur in coastal areas) or occur in aquatic habitats, which are addressed as part of Study No. 3.5.1. A list of upland invasive plant species with potential to occur in the Study Area are provided in Table 3.4.2-1.

Table 3.4.2-1: Upland Invasive Plant Species.

Scientific Name	Common Name	Lifeform Type	Notes
Acer platanoides	Norway maple	Tree	Common in woodlands with colluvial soils, grows full sun to full shade dispersed by water, wind and vehicles
Aegopodium podagraria	Bishop's weed	Perennial Herb	Occurs both in uplands and wetlands. Grows in full sun to full shade, spreads aggressively by roots; forms dense colonies in flood plains
Ailanthus altissima	Tree of heaven	Tree	Occurs in uplands, wetlands, grows in full sun to shade. Spreads from root suckers, especially in disturbed areas
Alliaria petiolata	Garlic mustard	Biennial Herb	Widespread, grows full sun to full shade, spreads by seed, especially in wooded areas
Berberis thunbergii	Japanese barberry	Shrub	Wooded uplands and wetlands, grows in full sun to full shade, spread by birds, forms dense stands
Celastrus orbiculatus	Oriental bittersweet	Perennial vine	Grows in full sun to partial shade, berries spread by birds and humans
Cynanchum louiseae	Black swallow-wort	Perennial vine	Grows in full sun to partial shade, forms dense stands, deadly to Monarch butterflies
Elaeagnus umbellata	Autumn olive	Shrub	Grows in full sun, berries spread by birds, aggressive in open areas
Euphorbia esula	Leafy spurge	Perennial herb	Occurs in grasslands
Frangula alnus	Glossy buckthorn	Shrub -Tree	Occurs in uplands and wetlands, grows in full sun to full shade, forms thickets
Hesperis matronalis	Dame's rocket	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, spreads

Scientific Name	Common Name	Lifeform Type	Notes
			by seed, can form dense stands in flood plains
Lonicera japonica	Japanese honeysuckle	Perennial vine	Widespread, grows full sun to full shade, climbs vegetation, seeds dispersed by birds
Lonicera morrowii	Morrow's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Lonicera x bella	Bell's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Polygonum cuspidatum	Japanese knotweed	Perennial Herb-Shrub	Widespread, grows in full sun to full shade, spreads vegetatively and by seed, forms dense thickets
Lysimachia nummularia	Creeping jenny	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, forms dense mats
Lythrum salicaria	Purple loosestrife	Perennial herb	Occurs in uplands and wetlands, grows in full sun to partial shade, high seed production, overtakes wetlands
Phalaris arundinacea	Reed canary grass	Perennial grass	Occurs in uplands and wetlands, grows full sun to partial shade, can form large colonies, common in agricultural settings
Phragmities australis	Common reed	Perennial grass	Grows in uplands and wetlands, full sun to full shade, forms dense stands, flourishes in disturbed areas
Polygonum perfoliatum	Mile-a-minute	Annual vine	Found along fields and road edges in full sun to partial shade, bird and human dispersed
Ranunculus ficaria	Lesser celandine	Perennial herb	Occurs in lowland and upland woods, grows in full sun to full shade, spreads vegetatively and by seed, forms dense stands
Rhamnus cathartica	Common buckthorn	Shrub-tree	Occurs in uplands and wetlands, grows in full sun to full shade.
Robinia pseudoacacia	Black locust	Tree	Occurs in uplands, grows full sun to full shade, aggressive in areas with sandy soils
Rosa multiflora	Multiflora rose	Shrub	Widespread, grows in full sun to full shade, forms thorny thickets, dispersed by birds.

The MIPAG species list of invasive plants will be utilized to identify targeted invasive species when conducting botanical meander surveys. Surveyors will use methods adapted from the NHESP and the United States Forest Service (USFS) Invasive Species Program, Invasive Species Inventory and Mapping Data Recording Protocols (USFWS, 2010). These adapted methods focus on presence, location, extent, abundance and other site characteristics to provide site infestation information. As land disturbances following Project maintenance activities may favor establishment of invasive plants over native plant communities, survey efforts for invasive species will be focused on disturbed lands, areas of vegetation management, access roads and recreational trails which can be vectors for invasive species propagation.

To document an infested area, biologists will use a GPS at sub-foot accuracy to delineate the boundary of the infestation as defined by the dominant canopy cover of the invasive plant. Areas containing only occasional invasive species will be characterized with a GPS center point and radius necessary to enclose the population. For areas where invasive species are ubiquitous or impractical to map, surveyors will characterize the invasive species population using estimates of aerial coverage and percent of species present within a defined polygon. Sampling areas containing invasive botanical species will be photo-documented and geo-referenced, and an Invasive Species Documentation Form will be completed.

Task 5: Land Management Practices and Recreation Uses

FirstLight will provide information to identify Project-related land management and maintenance practices and the usage of Project-related recreation areas. Annual maintenance activities are typically conducted during the growing season every year and may include vegetation management, erosion control, road maintenance, and other general project maintenance. Recreational use information of the Northfield Mountain study area will be gathered as part of the study plans under Section 3.6 Recreation and Land Use. This information will be analyzed with results from the wildlife and botanical field surveys at the Northfield Mountain Project to identify the relationship between Project facilities, recreational uses and wildlife and botanical resources and identify practices to avoid or minimize impacts.

Task 6: Data Analysis and Reporting

A draft and final technical report will be prepared for this study. The results of this study will provide both quantitative and qualitative information that will be important in defining existing conditions, as well as providing any information on potential project impacts as they relate to preparation of the License Application. The report will contain all supporting correspondence among licensing participants. The draft report will be revised to address final comments by licensing participants.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

This study would likely take one study season to complete. The estimated budget for the study ranges from approximately $40,000 to $60,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

This study will be conducted as follows:

- January – March 2014: Reviewing existing information and data
- March - August 2014: Conduct field reconnaissance surveys
- September - December 2014: Prepare data and report

Literature Cited

Swain, P.C., & Kersey, J.B. (2011). Classification of the Natural Communities of Massachusetts: Draft. Retrieved from http://www.mass.gov/dfwele/dfw/nhesp/natural_communities/natural_community_classification.htm. Accessed August 23, 2011.

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3.5 Wetlands, Riparian, and Littoral Habitat

3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species

General Description of Proposed Study

This study contains multiple elements. In addition to conducting an inventory of wetlands, riparian and littoral zone resources in the Turners Falls Impoundment, the methods in this study contain provisions for assessing Project impacts on state-listed plant species in the Turners Falls Impoundment as well as downstream of Cabot Station, and assessing Project impacts on state-listed invertebrate species that utilize riparian areas downstream of Cabot Station.

Several stakeholder groups submitted a request to FirstLight to study impacts of water level fluctuations due to operations at the Turners Falls and Northfield Mountain Pump Storage Project on riparian, wetland and littoral zone resources in the Turners Falls Impoundment. The USFWS, Town of Gill, LCCLC, FRCOG, CRWC, VANR, NHFG, NHDES, and TNC study requests were similar and requested that the applicant complete studies to obtain baseline information on riparian, wetland, littoral zone, and shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the Project area. Information would be used to determine whether riparian, wetland, submerged aquatic vegetation (SAV) and emergent aquatic vegetation (EAV), littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the license for the Turners Falls Project and Northfield Mountain Project. A baseline inventory will be conducted to map these resources and to determine if there is any unique or important shoreline or aquatic habitats in the Project area.

The MDFW also requested two additional studies related to the above requests. The first request (study request number 23) is to conduct a study to quantify the impacts of water level fluctuations and the current and proposed flow regimes on state-listed rare plant species in the Turners Falls Impoundment, and in the 13+ miles of riverine habitat below the Turners Falls Dam (to the Rt. 116 Bridge in Sunderland).

The second MDFW request (number 19) is to integrate modeled river flows and water levels with a habitat assessment for state-listed riparian invertebrate species. MDFW requested that the model should specifically assess the influence of existing and proposed Project operations on water levels at both known populations and potential habitats for the Cobblestone Tiger Beetle (*Cicindela marginipennis*), state-listed as "Endangered," and the Puritan Tiger Beetle (*Cicindela puritana*), state-listed as "Endangered" and federally-listed as "Threatened", and assess how Project operations may be modified to conserve and enhance existing populations and potential habitats.

As requested by the MDFW, this study will utilize the results of the Hydraulic Study as described in Section 3.2.2 to quantify and assess potential impacts of Project-related water level fluctuations on existing wetlands, riparian and littoral habitat resources including state-listed plant and invertebrate species.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals of this study are to characterize and describe the wildlife and botanical resources within the Project Area and assess the potential impacts of Project-related reservoir water level fluctuations on identified resources. The specific objectives of this study are to:

- Quantitatively describe and field verify National Wetland Inventory (NWI) mapped wetland types, describe and map shallow water aquatic habitat, including submerged aquatic vegetation (SAV) and emergent aquatic vegetation (EAV), substrate type, invasive species and associated wildlife in the Turners Falls Impoundment and up to 200 feet from the Turners Falls Impoundment shoreline within the Project boundary.
- Obtain baseline information, through field surveys, on the locations and population parameters of Massachusetts state-listed rare plant species in the Turners Falls Impoundment and the 13+ miles of riverine habitat below Cabot Station to the Rte. 116 Bridge in Sunderland.
- Analyze how the Project operations affect botanical and wildlife resources with an emphasis on how Project operations influence known or potential habitat of state-listed plant species and state-listed invertebrate species including the Cobblestone Tiger Beetle and the Puritan Tiger Beetle.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study will provide baseline information to agencies with jurisdiction over wetlands, riparian and littoral resources allowing them to address potential Project effects. The resource management goals identified are listed below.

Wildlife and freshwater fish resources are administered by USFWS, whose mission is to "conserve, protect and enhance and if needed mitigate fish, wildlife and plants and their habitats for the continuing benefit of the American people." In doing so, USFWS enforces wildlife laws, protects endangered species, manages migratory birds, and helps to restore important fisheries. They administer the ESA, designed to protect imperiled species from going extinct. Specific to the Turners Falls Project the Service goals are to:

- Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Minimize current and potential negative Project operation effects on water quality and aquatic habitat.

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the MADFW. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions and protection of wetlands and aquatic habitats of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The MADFW resource goals and regulatory requirements are to:

- Ensure that protection mitigation and enhancement measures are commensurate with Project effects and meet MESA and the WPA requirements for the Project.
- Conserve, protect, and enhance habitats for state-listed species that will be affected by Project operations.

Massachusetts Invasive Plant Advisory Group (MIPAG), a committee where the Massachusetts Natural Heritage Endangered Species Program (NHESP) is represented, maintains a list of invasive plant species in Massachusetts and provides criteria used in evaluating species. The NHESP management goal is to promote the conservation and protection of species that are not hunted, fished, trapped or commercially harvested in Massachusetts. The NHESP highest priority is protecting the state-listed RTE species. The overall goal of the program is the protection of the state's wide range of native biological diversity.

The VANR's resource management goals applicable to this study plan are:

- Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.
- Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
- Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

The New Hampshire Department of Environmental Services is primarily interested in the portion of the Turners Falls Impoundment that is in New Hampshire. NHDES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env- Wq 1703.01 (b)].

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

The PAD provides lists of plant and wildlife species whose native ranges overlap with the Project area, but it does not provide any site-specific information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the Project area. In addition, existing information in the PAD does not quantify EAV and SAV in the Project area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the Project area.

Small areas of known invasive SAV beds are present in the Turners Falls Impoundment in the vicinity of Barton's Cove. FirstLight is currently cooperating with the USFWS on hand pulling water chestnut plants in this area. A very small colony exists on the Gill and Montague sides, located between the upstream side of the Dam and the boat barrier.

Additional site-specific data are needed to meet the goal of evaluating Project effects. Studies will supplement existing information regarding vegetation mapping, sensitive plants, invasive plants, and presence of RTE species or associated habitat.

Section 4.6 of the PAD contains information about wetland vegetation mapped in area of the Project, including NWI maps. Other available information including FEMA floodplain maps, USGS 7.5 minute quadrangles, NRCS soil surveys, and aerial photography. While this information provides baseline data for analysis, there are no known site-specific assessments or ground-mapping data of wetland habitats within the Project boundary. Additional site-specific data are needed to evaluate specific Project effects. Field studies will supplement existing information in the following areas:

1. Refine existing mapping, which will include field verifying the NWI mapping; and

2. Identify and classify existing wetlands and other "waters of the U.S." in accordance with USACE practices to define areas subject to federal regulation and policies.

In preparation of the PAD, Federal and state agencies were contacted regarding the potential presence of RTE species and critical habitats within the Turners Falls Project and Northfield Mountain Project boundaries and included the USFWS, NMFS, Massachusetts NHESP, VTFWD, and NHFGD. The consultation resulted in the identification of three federally-listed threatened and/or endangered species (Section 4.7.1 of the PAD), 39 state-listed threatened and/or endangered species (Section 4.7.2 of the PAD), 21 state-listed species of special concern (Section 4.7.3 of the PAD) and designated critical habitat (Sections 4.7.4) that are likely or known to occur within the Project boundary and are detailed in Section 4.7 of the PAD.

Agency consultation revealed no federally designated critical habitat areas within the Turners Falls Project and Northfield Mountain Project areas; however, the Project areas may be located within or on a portion of State designated Natural Areas classified as priority habitats and/or estimated habitats. Detailed information regarding habitat preferences and life histories of these species can be found in Section 4.7 of the PAD.

The MADFW commented that several surveys along this stretch of the River have shown that many state-listed plant species are dynamic local populations and often display meta-population dynamics, changing in size and location from year to year. The MADFW commented that this is particularly true for plant species inhabiting sand bars and high energy shore and cobble islands, including (but not limited to) the state-listed Wright's Spike-rush, Intermediate Spike-sedge, Ovate Spike-sedge, Frank's Lovegrass and Tufted Hairgrass. Large and/or rapid changes in water elevation and/or flow dynamics may cause adverse effects to existing and potential habitat for state-listed plant species. FirstLight is not aware of any studies that evaluate the effects of these changes in water level elevations on the life cycle of state-listed species and in particular, the germination, growth, and dispersal of species inhabiting mudflats, sand bars, and cobble islands. A list of NHESP state-listed species for the Project is provided in Table 4.7.2.5-1 in Section 4.7.2.5 of the PAD.

Additional information is needed to analyze how Project operations have or will alter hydrology in the Connecticut River from below the Vernon Hydroelectric Project downstream to the Holyoke Dam, or how operations have or may affect known wildlife and botanical resources. Of particular concern is how operations have or may affect known populations and potential habitats for state-listed invertebrate species, including the Puritan and Cobblestone Tiger Beetles.

Puritan tiger beetle and the cobblestone tiger beetle populations are limited in Massachusetts. The only known population of each species is found along the Connecticut River, with Puritan tiger beetle known from a single site at Rainbow Beach in Northampton, MA, and cobblestone tiger beetle known from a single site in Montague, MA (first observed in 2000). Detailed surveys of Puritan tiger beetle have been conducted at Rainbow Beach for adults and larvae from 1997 to the present (Davis, 2011[44]).

Project Nexus (18 CFR § 5.11(d)(4))

The Turners Falls Project and Northfield Mountain Project provide a variety of wetland, riparian, and littoral habitat for a range of wildlife and botanical species. Water levels fluctuations have the potential to affect these water sensitive resources. An understanding of the locations and extent of resources in the Project area would provide information on the type and quantity of wildlife, plants, and habitat potentially affected by project operations. The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that

[44] Unpublished report submitted to U.S. Fish & Wildlife Service, Turners Falls, MA.

explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the License.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

A field survey will be conducted within the Turners Falls Impoundment and below Cabot Station to document the type and distribution of wildlife habitats and vegetation communities present in the Project area. The Study Area includes the following:

- Turners Falls Impoundment and land up to 200 ft from the shoreline of the impoundment within the Project boundary extending from the base of Vernon Dam to the Turners Falls Dam.
- The approximate 13+ miles of riverine habitat below the Turners Falls Dam to the Rte. 116 Bridge in Sunderland.

Field surveys will be conducted to observe conditions at the lowest practical water level operational range permitted on a daily operation schedule, under low flow conditions. In addition, the rate and height of water level changes resulting from Project operations during the field season will be cataloged to better understand the correlation of field observations and how they relate to field conditions during survey dates.

Task 1: Literature Review

Prior to the field reconnaissance surveys, existing information and data will be reviewed to identify areas of representative communities and potentially suitable habitat for protected species of interest. Using GIS and other available sources of information, a preliminary field map will be produced to assist field surveys. Pre-survey, biologists will review life histories of wildlife and phenology of listed plants for known listed species at the Project to select field survey windows to optimize observations.

Task 2: Riparian and Littoral Zone Botanical Survey

Botanical assessments will be completed to determine the species composition, structure, and distribution of vegetative communities. The types of data that will be collected include percent cover and dominate species within the herbaceous, shrub, and tree stratums along with the general distribution and juxtaposition of vegetative communities. Botanical field inventories listed in this task will employ the concepts of timed-meander surveys, which will involve walking a wandering path through each representative habitat type and recording species present until a period of time (typically 10 minutes) passes where no new species were added to the vegetation list. SAV's and EAV beds will be surveyed from a boat with use of look-down buckets to aid in identification. SAV and EAV beds will have their perimeter surveyed or will have a center point GPS with a radius offset that will encompass the entire bed.

Surveyors will compile a census list of all plants found within each respective habitat, and will maintain an overall list of all plant species identified within the Project Area. Plants will be identified to the species level if possible, at a minimum if the plant is outside its phenological peak, the plant will be identified to the genus level if species identification is not possible. If positive identification cannot be completed in the field, a voucher sample will be collected, pressed, and preserved for further identification when appropriate. Prior to the 2014 field survey, biologists will obtain the necessary collecting permit for any voucher samples that may need to be collected from the State Botanist at the Massachusetts NHESP. Other general information that will be gathered during meander surveys will include general health of communities and site quality conditions. Vegetation communities will be classified using NHESP Classification of the Natural Communities of Massachusetts (Swain & Kersey, 2011).

Sample vegetation plots will also be established to collect quantitative information to characterize the different habitats and provide species composition of habitat types. Vegetation plot locations will be selected using Massachusetts NHESP guidelines and protocols. Massachusetts NHESP Quantitative Community Characterization Forms (Massachusetts NHESP Form 3) will be completed for representative habitats to document the results of each plot location. Geo-referenced photographs will also be taken to document site conditions at the time of the survey.

To refine botanical information for the study area, the following tasks will be performed:

- Acquire and compile existing GIS vegetation cover type layers from available resources;
- Examine any visible vegetation boundaries in aerial photos or other imagery to fix or update type polygon boundaries, based on field observations;
- Produce a final vegetation type map that displays vegetation type polygon boundaries, the study area, and specific Project components;
- Use the vegetation type map to produce a table of vegetation types and calculate the percent acres of each vegetation type present in the study area in general, in areas potentially affected by the Project, and indirectly affected key wildlife habitats.

During botanical surveys, incidental wildlife observations will be noted and reported consistent with Study No. 3.4.1.

Task 3: Sensitive Plant Survey

A sensitive plant survey and completion of a biological evaluation on the locations and population parameters of Massachusetts state-listed rare plant species as identified in Section 4.7 of the PAD will be completed in the Turners Falls Impoundment and the 13+ miles of riverine habitat below the Dam to the Rte. 116 Bridge in Sunderland. Several surveys along this stretch of the River have shown that state-listed plant species are dynamic local populations and often display meta-population dynamics, changing in size and location from year to year. This is particularly true for plant species inhabiting sand bars and high energy shore and cobble islands, including (but not limited to) the state-listed Wright's Spike-rush, Intermediate Spike-sedge, Ovate Spike-sedge, Frank's Lovegrass and Tufted Hairgrass. Large and/or rapid changes in water elevation and/or flow dynamics may cause adverse effects to existing and potential habitat for state-listed plant species. This task will collect the necessary field information to evaluate the effects of these changes in water level elevations on the life cycle of state-listed species and in particular, the germination, growth, and dispersal of species inhabiting mudflats, sand bars, and cobble islands. In development of the PAD NHESP identified 36 listed plant species known to have historically occurred in the vicinity of the Project. The full listing of the state-listed rare plant species is provided in Table 4.7.2.5-1 in Section 4.7.2.5 of the PAD. Table 3.5.1-1 provides a list of 22 sensitive plant species of concern taken from the NHESP identified state listed species in the PAD that have a likelihood of inhabiting areas directly affected by water level fluctuations. The species omitted from Table 3.5.1-1 were not included due to habitat requirements of species that would not be found in areas affected by water level fluctuations (e.g., species that require rocky ledges at high elevations, ridgetops, upland talus slopes).

Table 3.5.1-1: Sensitive Plant Species of Concern.

Scientific Name	Common Name	State (MA) Status	Preferred Habitat	Section A=north of Turners Falls Dam B=south of Turners Falls Dam
Alnus viridis ssp. crispa	Mountain alder	Threatened	Occurs in several habitat types, which combine open, exposed areas and cool local temperatures. The most common habitat is exposed ledges, boulders, and cobble bars on the edges of the Connecticut and Deerfield Rivers.	A,B
Aplectrum hyemale	Putty-root	Endangered	Occurs in rich deciduous forests of mesic hardwood subject to occasional flooding by nearby waterways.	B
Arisaema dracontium	Green dragon	Threatened	Occurs in floodplain woodlands, with open to filtered light, typically in moist alluvial sites with annual flooding in lowlands areas along large rivers.	B
Carex grayi	Gray's sedge	Threatened	Occurs in moist alluvial soils of floodplain forests and riverside meadows. Tends to favor the lower slopes of swales and depressions.	A,B
Carex lenticularis	Shore sedge	Threatened	Generally restricted to wet, sandy or gravely beaches of cold ponds and lakes; or seasonally exposed rock cobble bars of large rivers.	A,B
Carex tuckermanii	Tuckerman's sedge	Endangered	Occurs in rich soils of lowland river floodplains including oxbows, lowland depressions, swales, forests, meadows, and vernal pools.	B
Carex typhina	Cat-tail sedge	Threatened	Occurs in seasonal forested floodplains and immediate proximity.	B
Deschampsia cespitosa ssp. glauca	Tufted hairgrass	Endangered	Occurs on rocky and gravely river shores	A,B
Elatine americana	American waterwort	Endangered	Occurs in the open muddy shores of ponds, tidal rivers and tributaries.	B
Eleocharis diandra	Wright's spike-rush	Endangered	Occurs on shady stream banks in floodplains	A,B

Scientific Name	Common Name	State (MA) Status	Preferred Habitat	Section A=north of Turners Falls Dam B=south of Turners Falls Dam
Eleocharis intermedia	Intermediate spike-sedge	Threatened	Occurs in marshes, freshwater mudflats and other wet areas containing muddy substrates. Often found in exposed mud during periods of low water on alkaline river banks and pond shores.	A,B
Eleocharis ovata	Ovate spike-sedge	Endangered	Occurs in the sandy margins of lakes, ponds and rivers.	A,B
Ludwigia polycarpa	Many-fruited false-loosestrife	Endangered	Occurs almost exclusively in seasonal river floodplains with wet exposed mud including oxbows and lowland depressions.	B
Mimulus alatus	Winged monkey-flower	Endangered	Occurs in seasonal floodplains on the banks of stream tributaries to rivers.	A,B
Morus rubra	Red mulberry	Endangered	Typically occurs on steep ledges or rocky slopes but can also be found in floodplains and other rich woodlands.	A
Nuphar microphylla	Tiny cow-lily	Endangered	Occurs in shallow, still or slow-moving waters that are not acidic. Typically found in oxbows, coves and backwaters.	B
Prunus pumila var. depressa	Sandbar cherry	Threatened	Occurs at the edge of floodplain forests, traprock ledges in river channels, sand flats, and riverbed cobbles and gravels near the floodline.	A,B
Rumex verticillatus	Swamp dock	Threatened	Occurs in light shade to full sun in wet and mucky soils.	B
Salix exigua ssp. interior	Sandbar willow	Threatened	Occurs on islands, sandbars and beaches in the seasonal floodplain of rivers where it is typically found in sandy, gravelly and rocky substrates.	A,B
Symphyotrichum tradescantii	Tradescant's aster	Threatened	Fissures and cracks of rocky stream or river banks, adjacent to exposed ledges at or below the high water mark, subject to flooding.	A,B
Tillaea aquatica	Pygmyweed	Threatened	Margins of ponds and rivers, in sandy and/or muddy wet soils.	B
Trichostema brachiatum	False pennyroyal	Endangered	Open sunny exposures on dry sandy soil, sandstone, or limestones. Known to occur along stream banks and railroad beds.	B

The sensitive plant survey will utilize guidelines and modified protocols established by the Massachusetts NHESP, VDFW Wildlife Diversity Program, and the NHFG Nongame and Endangered Wildlife Program. The sensitive plant survey will document state-listed plant species provided in the above table 3.5.1-1. In addition Northeastern bulrush (*Scirpus ancistrochaetus*), a federally listed plant species and frank's love grass (*Eragrostis frankii*), a NHESP species of special concern, will also be included in the sensitive plant survey. Field efforts will particularly focus on plant communities that exhibit meta-populations inhabiting the shoreline, mud flats, sand bars, and high energy shore and cobble island habitat types which are directly affected by water level fluctuations. The shoreline of the study area will be surveyed to locate all high probability areas that have suitable habitat and a high likelihood for sensitive plant associations. In identified areas having high likelihood of sensitive plants a timed- per unit area approach will be conducted to provide a census of the area. The time per unit area will be determined based upon the extent of the survey area, location, and the complexity of the plant diversity and population densities. Areas that are observed having listed species will include dates and times, the areas that were surveyed, and elevations taken with a level rod of observed species relative to river levels during the time surveyed. These data will be utilized to correlate operational impacts of fluctuating water levels on observed listed species. Species identified will be recorded for each site investigated and will also be added to the overall plant species census list for the Project.

The exact areas of focus will be determined after more extensive review of available information and based on professional judgment in the field. Areas having a known record of special status plants as determined in the pre-survey review and that may be affected by Project operations will be surveyed to cover 100 percent of the area to the extent possible. Positive identification of state-listed plant species will be photo-documented and GPS-located.

Task 4: Invasive Plant Survey

The MIPAG maintains a list of 34 noted invasive plant species occurring in Massachusetts and provides criteria used in evaluating species. Invasive plants as defined by the MIPAG are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. Of the 34 plants listed by the MIPAG a total of 9 invasive species have been identified with the potential to occur in the aquatic habitats associated with the Study Area. Invasive plants identified by the MIPAG not included in this study were omitted based on regional occurrence (coastal areas) or occur in terrestrial habitats, which are addressed as part of Study No. 3.4.1. A list of wetland and aquatic invasive plant species with potential to occur in the Study Area are provided in Table 3.5.1-2.

Table 3.5.1-2: Wetland and Aquatic Invasive Plant Species.

Scientific Name	Common Name	Lifeform Type	Notes
Cabomba caroliniana	Carolina Fanwort	Aquatic herb	Chokes waterways
Iris pseudacorus	Yellow Iris	Perennial herb	Wetland habitats, primarily in flood plain areas, grows in full sun to full shade
Lysimachia nummularia	Creeping Jenny	Perennial herb	Problematic in flood plains forms dense mats
Lythrum salicaria	Purple Loosestrife	Perennial herb	Overtakes wetlands, high seed production
Myriophyllum heterophyllum	Variable water-milfoil	Aquatic herb	Chokes waterways, spreads by humans, boat traffic, and possibly birds
Myriophyllum spicatum	Eurasian water-milfoil	Aquatic herb	Chokes waterways, spreads by humans, boat traffic, and possibly birds
Phalaris arundinacea	Reed Canary Grass	Perennial grass	Forms dense stands
Potamogeton crispus	Curly Pondweed	Aquatic herb	Forms dense mats in the spring and persists vegetatively
Trapa natans	Water-chestnut	Aquatic herb	Forms dense floating mats on water

The MIPAG list of wetland and aquatic invasive plant species will be utilized to identify targeted invasive species when conducting botanical meander surveys. Surveyors will use methods adapted from the USFS Invasive Species Inventory and Mapping Data Recording Protocols (USFWS, 2010). These adapted methods focus on presence, location, extent, abundance and other site characteristics to provide site infestation information.

Aquatic invasive plant species will be located by use of a boat and on foot, with identification of aided by the use of look-down buckets. Invasive infestations occurring in areas outside but adjacent to the impoundment will be surveyed by foot. Survey efforts will map the known areas of invasive water chestnut beds present in the Turners Falls Impoundment in the vicinity of Barton's Cove, and if still present, the small colony located between the upstream side of the Dam and the boat barrier on the Gill and Montague sides. To document an infested area, biologists will use a GPS at sub-foot accuracy to delineate the boundary of the infestation as defined by the dominant canopy cover of the invasive plant. The intent of this survey is to document significant infested areas of invasive plant species. Areas containing only occasional invasive species will be characterized with a GPS center point and radius necessary to enclose the population. For areas where invasive species are ubiquitous or impractical to map, surveyors will characterize the invasive species population using estimates of aerial coverage and percent of species present within a delineated polygon. ~~As land disturbances following Project maintenance activities may favor establishment of invasive plants over native plant communities, survey efforts for invasive species will be focused on disturbed lands, areas of vegetation management, access roads and recreational trails, which can be vectors for invasive species propagation.~~ For areas where dense stands of wetland or aquatic invasive species have formed, areas will be photo-documented and geo-referenced, and an Invasive Species Documentation Form will be completed.

Task 5: Mapping Wetlands and Waters of the United States

Within the Turners Falls Impoundment and up to 200 feet from the Turners Falls Impoundment shoreline within the Project boundary, FirstLight will describe and field verify National Wetland Inventory (NWI) mapped wetlands. Initial determination of wetland areas will be conducted through the use of existing information such as existing FirstLight site knowledge, NWI maps, FEMA floodplain maps, USGS 7.5 minute quadrangles, soil surveys, and aerial photography. This information will be transferred and digitized into a GIS and preliminary wetland base maps will be prepared. This GIS wetland overlay will also be incorporated into an overall habitat or cover type map detailing all the habitat areas found in the project area or influenced by the Project.

Using the preliminary base wetland maps, field assessments will be completed to verify, classify and characterize the wetland communities. A team of qualified wetland scientists will complete the field assessments during the 2014 growing season when vegetation is most readily identifiable. Wetland habitats will not be formally delineated, but will be further defined from the existing NWI maps. NWI wetland boundaries will be extended where applicable and if encountered non-NWI wetlands will also be mapped. Wetlands will be identified using standard federal criteria and methods outlined in the USACE Wetland Delineation Manual and the Regional Supplement to the USACE Wetland Delineation Manual: North Central and Northeast Region (USACE, 1987; USACE, 2012). Wetland types mapped will be classified using the USFWS Cowardin wetland classification system (e.g., palustrine, unconsolidated bottom, riverine aquatic bed) (Cowardin et al., 1979). General wetland verification and mapping will be completed using a GPS at sub-foot accuracy. Points collected in the GPS will be transferred to the GIS data base to assist in the creation of the final wetland presentation including location, type, and extent.

Evaluations and analysis of wetland functions and values will use the standard USACE descriptive approach (also known as the ACE Highway Methodology) (USACE, 1999). The ACE method is a descriptive (qualitative) approach for evaluating the functions and values of wetlands, which directs the user to identify the functions and values associated with a particular wetland based on the presence or absence of certain characteristics. For each wetland type, standard data will be recorded for the most important biotic and abiotic characteristics as the basis for identifying important wetland functions and values. This assessment will be completed holistically for each wetland type. A functional analysis of each wetland is not necessary because wetland "types" are functionally similar. Investigators will identify the "principal" or important functions and values associated with each wetland or wetland type.

Task 6: Project Water Level Fluctuation Assessment

A HEC-RAS model in an unsteady state will provide data to determine the contribution of water level fluctuations associated with Project operations. This hydraulic model will be developed as part of Study No. 3.2.2. Specifically, this information will be used to address how hydraulically connected habitats and vegetation is affected, and how operations have or may affect known populations and potential habitats for state-listed invertebrate species, including the Puritan and Cobblestone Tiger Beetles.

The Puritan tiger beetle is known from a single site at Rainbow Beach in Northampton, MA, and cobblestone tiger beetle known from a single site in Montague, MA (first observed in 2000). Detailed surveys of Puritan tiger beetle have been conducted at Rainbow Beach for adults and larvae.

A cross-section will be established in known areas of cobblestone tiger beetle and Puritan tiger beetle habitat for use in conjunction with the model results. The cross-section information will include depth and substrate measurements. FirstLight will consult with NHESP to determine how many cross-sections will be needed to define the models parameters of the model. The model output will provide information on water level elevation changes in relation to Connecticut River flows under a variety of test conditions.

Task 7: Data Analysis

Following field surveys, GIS-based maps will be developed depicting wetland habitats, SAVs, EVAs, invasive species, RTEs, and other related information collected during the study. The field data collected will be geo-referenced as polygons or point data and overlain on orthophotos at a suitable scale. Field data will then be subject to QA/QC procedures, including spot-checks of transcription and comparison of GIS maps with field notes to verify locations of wetland sites and wetlands found. The results of this study will provide both quantitative and qualitative information that will be important in defining existing conditions, as well as providing any information on potential Project impacts as they relate to preparation of the License Application. This study is consistent with methodologies of generally accepted scientific practices and uses standard federal wetland assessment methods developed and used by Federal land management agency personnel.

Task 8: Reporting

A draft report will be prepared for study team review and comment, documenting methods and results. The report will provide the baseline information to defining existing conditions as well as analytical discussions and conclusions of potential Project impacts. The report will contain appendices of survey data and supporting correspondence among licensing participants. The report will be finalized following receipt of input from the study team and revisions to address any final comments by licensing participants.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

This study will likely take one study season to complete and will be conducted during the 2014 field season. The estimated cost for the study could range from approximately $60,000 to $80,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

This study will be conducted as follows:

- January – March 2014: Reviewing existing information and data
- March - August 2014: Conduct field reconnaissance surveys

- September - December 2014: Prepare data and report

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3.6 Recreation and Land Use

3.6.1 Recreation Use/User Contact Survey

General Description of Proposed Study

This study was originally proposed as part of the PAD. FERC has requested a Recreation Facility Inventory and Use and Needs Assessment. In particular, FERC requested that FirstLight conduct a study to determine the existing use and demand at the projects and an assessment of the need to enhance recreation opportunities and access at the Projects. FERC proposed that the data be collected using on-site visitor intercept surveys at formal and informal public recreation areas at the Project reservoirs, tailraces, and riverine areas, including the Turners Falls bypassed reach; and mail and/or internet surveys targeting unique stakeholder groups that may not be practically accessed through on-site surveys (e.g. adjacent residential landowners, residents of the counties in which the projects are located, rock climbers, whitewater boaters).

FirstLight proposes to conduct a user count at the Turners Falls Project and Northfield Mountain Project recreation sites using both pressure tube counters and visual counts, including calibration counts to support the tube counters. FirstLight also proposes to develop and conduct contact surveys to determine the views of the recreating public with regard to the available recreation sites and activities within the Turners Falls Project and the Northfield Mountain Project boundary and to also request zip code information to assist with determining user distribution. It is anticipated that conducting the contact surveys at formal recreation sites will capture use by the majority of Project recreation users, including use at informal sites. This is because the majority of individuals utilizing informal sites within the Projects will access the sites via formal recreation facilities.

In addition, FirstLight proposes to conduct a mail survey targeted at adjacent residential landowners. The targeted mail survey should capture the majority of recreational use that may not originate at formal and informal sites. FirstLight is not proposing to conduct a mail survey of residents of the counties in which the Projects are located because the high cost of a general mail survey outweighs the uncertain benefit of a mail survey. The results of county-wide surveys tend not to be representative of the general recreational user population and produce unreliable results. There are an estimated 97,844 households in the three counties in which the Projects are located. Depending on the survey return rate, the estimated cost of conducting a mail survey, using a modified Dillman method, for 97,844 households could range from $700,000 to more than $1,605,000.00. FirstLight is not proposing to conduct internet surveys as part of this study. Internet surveys are generally not appropriate for quantitative analysis because the results tend not to be representative of the general recreational user population and are not reliable.

FirstLight proposes to use the information from the *Recreation Use/User Contact Survey* in conjunction with the *Recreation Facilities Inventory and Assessment* (Study No. 3.6.2), the *Whitewater Boating Evaluation* (Study No. 3.6.3), the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4), and the *Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use* (Study No. 3.6.7) to determine the sufficiency of existing recreation facilities in meeting recreation demand at the Projects and to assess the need to enhance recreation opportunities and access at the Projects.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of the study are:

- Determine the amount of recreation use and demand at the Turners Falls and Northfield Mountain recreation sites; and
- Interview the recreating public to determine user opinions and goals with regard to the recreation sites, including the perceived adequacy of recreation facilities and access at the Project.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the operation of the Turners Falls and Northfield Mountains Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

Section 4.8 of the PAD provided information regarding recreation resources within the Projects and surrounding area. Recreation use at the Turners Falls Project and Northfield Mountain Project occurs in all seasons and includes motorized and non-motorized boating, fishing, camping, canoeing, climbing, sightseeing, hunting, skiing, hiking, walking, biking, horseback riding, and picnicking. There are multiple recreation facilities within the Projects' boundaries that offer a variety of water-related and upland recreation opportunities. In general, areas associated with the Turners Falls Project and the Northfield Mountain Project are open to the public for recreation use. There is no public access to the upper reservoir, and the reservoir is surrounded by a security fence. It can be viewed, however, from a platform on a nearby trail.

There are 20 formal recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. These facilities provide a variety of amenities, including but not limited to boat ramps, camp sites, picnic tables, benches, trails, and interpretive displays. Lands within the Northfield Mountain Project contain Rose Ledge and Farley Ledge, both of which are routinely used by climbers.

The 2009 Form 80 for the Turners Falls Project reported that the total annual daytime use was 36,694 recreation days, and the total annual nighttime use was 4,584 recreation days. The peak weekend daytime average use was 339 recreation days, and the nighttime average was 27 recreation days. The interpretive displays were used at 80% of facility capacity, while the trails were used at 5% of their capacity. Parks and picnic areas in the Project were used at 35% of the facility capacities. The canoe portage and tailwater fishing facilities were used at 10% of their capacities.

The 2009 Form 80 for the Northfield Mountain Project reported that the total annual daytime use was 71,672 recreation days, and the total annual nighttime use was 4,564 recreation days. The peak weekend daytime average was 2,360 recreation days, and the nighttime average was 207 recreation days. The tent/trailer/RV sites and group camps were used at 80% of the facilities' capacities, while the interpretive displays were used at 20% of their capacity. The parks were used at 28% capacity, trails were used at 25% capacity, picnic areas were used at 24% capacity, and the Tour and Trail Center was used at 50% capacity.

Need for Additional Information:

Information on current use and whether existing access facilities in the area are meeting recreation demand would inform a decision on whether additional, designated public access at the Projects is necessary to meet existing and future recreation demand at the Projects.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of Project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

To determine the amount of recreation use at the Projects, the Licensee proposes to conduct a recreation use study in combination with a user contact survey and mail survey.

Task 1: Study Preparation

FirstLight will develop a user contact survey and determine the survey dates and times. All sampling days will be randomly selected and survey routes will be completed on a rotating basis and at different times of day to account for time-of-day use patterns. FirstLight also will develop a mail questionnaire/survey, based on Dillman approaches for developing mail surveys, which will be designed to ascertain recreational use by residential abutters. The Licensee will review readily available municipal and NGO recreation plans for information regarding recreation use within the Turners Falls and Northfield Mountain Project boundaries. A draft user contact survey, a Northfield Mountain trail user survey, and a mail survey of residential abutters are included with this study plan. See Figures 3.6.1-1, 3.6.1-2, and 3.6.1-3. Prior to the filing of the RSP, FirstLight will hold an additional meeting with stakeholders to review and obtain comments on the proposed survey instrument contained herein.

FirstLight will also consult with the Western Massachusetts Climbers Coalition, prior to finalizing a method of survey collection and developing a survey instrument with respect to climbing use of Rose and Farley Ledges.

Task 2: Field Work

The recreation use study will occur over four seasons in order to capture recreational use occurring in spring, summer, winter, and fall. It will be conducted using a combination of pressure tube traffic counters, calibration counts, spot counts, and actual use numbers. Tube counters will be placed at high use facilities within the Projects. These will be used to obtain an estimate of the number of vehicles using the site. The counters will be checked on Friday afternoon and Monday mornings to differentiate between weekday and weekend use.

Information collected with traffic counters will be started the week prior to Memorial Day and counters will be removed during the week after the closing of individual facilities. The counters will be placed on well used entrance/exit driveways accessing Project recreation facilities including driveways leading to local, state, and private facilities open to public recreation, if permission can be obtained from the owner /operators for placement and calibration counts.

Calibration counts will be conducted at each formal Project recreation facility and will be documented on a survey form. These counts will last for at least two hours per site on each calibration day and will be conducted on five (5) days per month which will include three (3) randomly selected weekdays and two (2) randomly selected weekend days. If a month contains a holiday, one (1) day per holiday weekend will be included in addition to the standard calibration days. A stratified random sampling methodology will be used to vary the days, time of day and start locations for the survey route. This will ensure that different user groups are captured as part of the study. This information will be used to verify that the traffic counters are functioning properly, determine the average number of individuals per vehicle, and determine the type of recreation use individuals are participating in.

The spot counts will be conducted on five (5) days per month which will include three (3) randomly selected weekdays and two (2) randomly selected weekend days. If a month contains a holiday, one (1) day per holiday weekend will be included in addition to the standard calibration days. at all formal recreation areas within the Project. This information will be documented on a survey form. The spot counts will record the number of vehicles parked at a facility to determine the time-of-day use patterns at the sites. FirstLight currently charges a fee for winter recreation use at the Northfield Mountain Project and for their interpretive riverboat cruises. This information will be combined with the collected field data, when developing the user figures for the Projects. Final recreation use for the formal recreation facilities within the Projects will be summarized by season and activity type for each site. FirstLight will work with State agencies and private groups (e.g., Franklin County Boat Club, Turners Falls Rod and Gun Club, and Northfield Mount Hermon School) that manage existing public and private recreation facilities within the Project boundaries to determine use at their facilities.

A user contact survey (Figure 3.6.1-1) and a Northfield Mountain trail user survey (Figure 3.6.1-2) will be used to determine user opinions and goals with regard to the existing Project recreation facilities and opportunities such as whitewater and other boating opportunities, overnight camping, trail use, and rock climbing. The user contact survey will take place over the course of four seasons. The survey will also ask for the individuals' zip code to determine how far existing users travel to visit the Projects for recreational purposes. This information will also be used to determine length of stay, number of people in a party, and the opinion of the user with regard to the amount and types of recreation opportunities offered within the Projects' boundaries. The survey will be administered during the calibration and spot count site visits.

A mail survey (Figure 3.6.1-3), using a modified Dillman method, will be mailed in the spring to residential abutters and a follow-up reminder card will be mailed out approximately two weeks later to those residences who have not returned a survey. It is assumed that approximately 25-40% of the targeted mail surveys will be completed and returned.

Task 3: Data Entry and Statistical Analysis

Information collected during Task 2 will be entered into spreadsheets for statistical analysis. Information such as the number of recreation days spent at the Projects' recreation sites, length of stay, average number of persons per party, and the percent of the facilities' capacity that is currently being utilized will be determined.

Task 4: Report Writing

The information that is gathered during this effort will be used to complete both the recreation and land management portions of the license application, as well as the FERC Form 80. Information from this study will be incorporated into a Recreation Management Plan along with information from several other studies.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain baseline information on recreational usage and demand within the Projects' area. The estimated cost for the recreation inventory and user contact survey outlined in this plan is approximately $105,000-$115,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. Prior to the filing of the RSP, FirstLight will hold an additional meeting with stakeholders to review and obtain comments on the proposed survey instrument contained herein.

Field data collection for this study will take place in January 2014 through December 2014. Statistical analysis of the data will occur in 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Figure 3.6.1-1: Draft Recreation User Survey

Interviewer: ____________ Date/Time: ________________ Location: _______________
Weather: _______________ Declined Survey: _____________

1. Have you participated in this survey effort before? Yes_____ No_____
2. How many in your group, including yourself? __________________
3. Which of the following best describes your group? (Check One)

☐ Alone	☐ Multiple Families	☐ Organized Outing Group
☐ Family	☐ Family & Friends	☐ Other_______
☐ Friends		

4. How many vehicles did your group use to come here? _____________
5. Have you ever visited the Turners Falls/Northfield Mountain Project before? Yes__ No__
   If yes, typically, how many times a year do you visit the Project for Recreation? _________
6. What is your zip code? ___________
7. When did you arrive and plan to depart from the Project?
   Arrived: Date: _________ Time: ______ AM PM
   Estimated Depart: Date: _________ Time: ______ AM PM
8. Please indicate which of the following activities you will participate in at the Northfield/Turners Falls Project. (Mark all that apply
   - Waterskiing/tubing
   - Fishing from a boat
   - Fishing from shore
   - Hiking/walking/running
   - Camping
   - Picnicking
   - Sightseeing
   - Road Bicycling
   - Mountain Biking
   - Horseback Riding
   - Skiing/snowshoeing
   - Hunting
   - Riding jet skis
   - Canoeing/kayaking
   - Power boating
   - Climbing
   - Driving for pleasure
   - Sailing
   - Photography/nature observation
   - Whitewater boating
   - Ice Fishing
   - Other
9. Of the activities listed above, which is your PRIMARY activity on this trip?
   ____
10. During your visit to the Turners Falls/Northfield Mountain Project today, using a scale of one (1) to five (5), with one (1) being not crowded and five (5) being extremely crowded what is your perception of the amount of use occurring at this site?

11. Did you experience any conflict with other recreation users in the Turners Falls/Northfield Mountain Project during this visit? Yes_____ No_____
    If yes, what detracted from your recreation experience? ____________________________
12. How satisfied are you with the reservoir water level during your trip? (choose #)
    On a scale of one (1) to five (5), with one (1) being not at all satisfied and five (5) being extremely satisfied.
    If less than satisfied could you explain why?_____________________________________
    ____
13. Please rate the following amenities at this location

	Poor		Fair		Excellent
Parking	1	2	3	4	5
Facility Condition	1	2	3	4	5
Variety of Amenities	1	2	3	4	5
Overall Quality	1	2	3	4	5

Please explain any poor ratings. ____
____

14. Does this recreation facility serve your interests? Yes____ No_____
    If not why?____
    ____
    ____

Figure 3.6.1-2: Northfield Mountain Trail User Survey

1. What is your zip code? _____________

2. How often, on average, do you use the Northfield Mt. trail system? (circle one response)

Daily
Between 3 and 5 times a week
1 or 2 times a week
Once a week
A couple of times a month
Once a month
A few times a year
First time

3. What is your primary activity or activities on the trail today? (circle all that apply)

Walking/ Hiking
Biking
Jogging/Running
Horseback Riding
XC Skiing/Snowshoeing
Other Activity (specify) __________

4. Do you participate in the other activities on the trail? Yes____ No____
If yes, please list:____

5. Were you readily able to negotiate the trails you elected to use today? Yes___ No____
If no, please explain any difficulties:____
____
____

6. Have you experienced conflicts with other trail uses of the trail system? Yes____ No____
If yes, what were those conflicts? Explain:____
____

7. Generally, when do you use the trail system? (circle one response)

Weekdays
Weekends
Both

8. How much time do you generally spend on the trail each visit? (circle one response)

Less than 30 minutes
30 minutes to 1 hour
1 to 2 hours
More than 2 hours

9. How did you learn about the Northfield Mountain trails? (circle all that apply)

Local Resident
Word of mouth
Roadside signage
Driving past
Internet web site
Other ___________________

Questions require a map of the trail system with numbered sections and access points.

10. What portions of the trail system do you use most often? (Sections ____________)

11. Which trail access point do you generally use when you visit the trail? (Access Point______)

12. Where did you park when accessing the trail system? ________________________________

13. Does the Northfield trail system serve your interests? Yes____ No_____
If not why?____

Figure 3.6.1-3: Residential Abutters Survey

1. Please categorize your abutting property by type of residence and land use by circling below
Residence: Seasonal Year Round

Current Use of Land: Residential, Landscape, Cropland, Livestock, Tree Growth,
Future Residential, Conservation Land, Other_______________________________

2. Do you as an abutting landowner regularly access the Project land and/or waters adjacent to your property for recreational purposes? Yes____ No____

3. Approximately how many days per year do you access the Project for recreation purposes?
1-25 26-50 51-100 Over 100

4. What recreational pursuits do you usually participate in?

- *Waterskiing/tubing*
- *Fishing from a boat*
- *Fishing from shore*
- *Hiking/walking/running*
- *Camping*
- *Picnicking*
- *Sightseeing*
- *Road bicycling*
- *Mountain biking*
- *Horseback riding*
- *Skiing/snowshoeing*
- *Hunting*
- *Riding jet skis*
- *Canoeing/kayaking*
- *Power boating*
- *Climbing*
- *Driving for pleasure*
- *Sailing*
- *Photography/nature observation*
- *Whitewater boating*
- *Ice fishing*
- *Other ___________________*

5. Do others access the Project across your private property? Yes___ No____
With permission?_____ Without permission?_____
Comments____

6. Do other parties utilizing Project lands and waters for recreational purposes affect your abutting property? Yes____ No____
If yes, explain____
____

7. Are there any other recreational issues at the Projects that you would like to comment on?
____
____

3.6.2 Recreation Facilities Inventory and Assessment

General Description of Proposed Study

The majority of this study was conducted in 2011 and 2012 in order to collect baseline information on recreation facilities associated with the Projects and a summary of the results were originally presented in the PAD. Due to low snow years in 2011 and 2012, the winter field work of this baseline survey was not conducted until March 2013. This study was designed to confirm the number of existing recreation facilities, the number and types of amenities available at each facility and the overall condition of the facilities. In its study requests, FERC requested information on the condition of existing recreation facilities and access sites at the Projects. The intent of the proposed study is to prepare a summary report that identifies the number of existing recreation facilities and access sites, and the amenities and the overall condition of the facilities and access sites.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The objective of this study is to complete the baseline investigation of the existing recreation facilities within the Turners Falls Project and Northfield Mountain Project boundary with the preparation of a summary report of the results.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreation opportunities associated with the presence and operation of the Turners Falls and Northfield Mountain Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

There are 20 formal recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. These facilities provide a variety of amenities, including but not limited to boat ramps, camp sites, picnic tables, benches, trails, and interpretive displays. Below is a brief description of each of the recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. The facility locations can be seen in Figure 3.6.2-1.

Cabot Woods Fishing Access: This site is located within the Turners Falls Project on Migratory Way in Montague, MA. This site is owned and managed by the Licensee and is open to the public for day use activities such as fishing, hiking, and picnicking. There are picnic tables, three ADA parking spaces, and 17 parking spaces available at the site.

Turners Falls Branch Canal Area: This site is located within the Turners Falls Project, off of Power Street in Montague, MA. This site is owned and managed by the Licensee and is open for fishing. Parking and benches are available at this site.

Turners Falls No. 1 Station Fishing Access: This site is located within the Turners Falls Project, off of Power Street in Montague, MA. This site is owned and managed by the Licensee and is open for fishing. Parking is available.

Unity Park: This park is located within the Turners Falls and Northfield Mountain Projects, on either side of First Street in Montague, MA. This site is owned by the town of Montague, with a portion on the east side that is owned by the Licensee. The park facilities located on the south side of the road are managed by the town of Montague, while the portion of the park located between the river and the road is managed by the Licensee. The park offers day use activities including walking, fishing, sightseeing, picnicking, and biking. Amenities at the park include restrooms, a playground, parking, ballfields, a basketball court, a paved trail, benches, and picnic tables.

<u>Canalside Trail Bike Path</u>: This bike trail is located within the Turners Falls Project along the Turners Falls Power Canal in Montague, MA. The trail property is leased to and managed by the MA Department of Environmental Management (now MA Department of Conservation and Recreation) and is open for non-motorized public use.

<u>Turners Falls Fishway Viewing Area</u>: This site is located within the Turners Falls and Northfield Mountain Projects, off of First Street in Montague, MA. The fishway is managed by the Licensee and is located at the southern end of Unity Park. The facility is open to the public in the spring to watch migrating fish.

<u>Barton Cove Nature Area and Campground</u>: This Nature Area is located within the Turners Falls and Northfield Mountain Projects, on Barton Cove Road in Gill, MA. The Nature Area is owned and managed by the Licensee and is open to the public for camping, picnicking, and bank fishing. Campsites have a picnic table, fire ring and garbage can. There are two vault toilets and additional portable restrooms located within the campground. There is water access from some of the sites and bank fishing is permitted.

<u>MA State Boat Launch</u>: This launch is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the state of Massachusetts, and is open to the public. The site offers boat launching and bank fishing opportunities. There is a parking lot, boat ramp, dock, and portable sanitation facility.

<u>Barton Cove Canoe and Kayak Rental Area</u>: This site is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the Licensee and offers day use opportunities. There is a canoe/kayak launch, a rental office, picnic tables, parking, and a portable sanitation facility.

<u>Cabot Camp</u>: This camp is located within the Turners Falls and Northfield Mountain Projects, at the end of Mineral Road in Montague, MA. The site is owned and managed by the Licensee and is open to the public as an informal bank fishing area. There is a large parking area and access to a local bike trail from the site.

<u>Northfield Mountain Boat Tour and Riverview Picnic Area</u>: This picnic area is located within the Northfield Mountain Project, off Pine Meadow Road in Northfield, MA. This site is owned and managed by the Licensee, and is available for day use activities including interpretive riverboat cruises, picnicking, and bank fishing. The site is accessible from the water and via a paved road. There is a formal parking lot available for those using the site and those who are boarding the riverboat. There are picnic tables, grills, sanitation facilities, and a boat dock at the site.

<u>Northfield Mountain Tour and Trail Center:</u> This site, which is also known as the Visitor Center, is located within the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in Northfield, MA. The Center is owned and managed by the Licensee and is available for day use activities. Available opportunities include viewing interpretive displays, picnicking, and educational programs. The Center has restrooms, cross-country ski rental equipment, and parking. It is open for year-round recreational and educational use.

Northfield Mountain Trail System: The trail system is located at the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in Northfield, MA. Over twenty-six miles of trail are available for hiking, biking, horseback riding, snowshoeing, and cross-country skiing.

Northfield Mountain Mountaintop Observation Area: This site is located adjacent to the Northfield Mountain Project upper reservoir. The Observation Deck is owned and managed by the Licensee and is accessible by hiking the trail system.

Munn's Ferry Boat Camping Recreation Area: This site is a water access site located on the east side of the river in Northfield, MA. The camping area is located within the Turners Falls and Northfield Mountain Projects. This area is owned and managed by the Licensee and is available for overnight use. There are tent campsites each with a trash can, tent platform, picnic table, fire ring and grill. There is also a lean-to site with a trash can, tent platform, picnic table, fire ring and grill. There are pit toilets available at the site. Bank fishing opportunities are also available at this site.

Bennett Meadow Wildlife Management Area (WMA): The Bennett Meadow WMA is managed by the state of Massachusetts, Division of Fisheries and Wildlife. The site is located within the Turners Falls and Northfield Mountain Projects. This site offers day use opportunities; it is open for hunting, and is also used for walking and hiking.

Pauchaug Boat Launch: This site is owned and managed by the state of Massachusetts. The site is located within the Turners Falls Project and Northfield Mountain Project. There is a boat launch, parking and portable sanitation available at this site.

Pauchaug WMA: This WMA is owned and managed by the state of Massachusetts, Division of Fisheries and Wildlife. This site is similar to the Bennett Meadow WMA and is located within the Turners Falls Project and Northfield Mountain Project. The site is open for hunting and is used for walking/hiking and bank fishing.

Governor Hunt Boat Launch/Picnic Area: This site is owned and managed by TransCanada, which owns the Vernon Project. While this area is within the Vernon Project boundary, the area is also located in the area where the Turners Falls Project and Northfield Mountain Project boundaries and the Vernon Project boundary overlap. The area is open for day use opportunities and has a picnic area and boat launch. Recreation opportunities at the site include bank fishing, picnicking, boat launching, and sightseeing.

Turners Falls Canoe Portage (Poplar Street Put-in): Portages around the Turners Falls Dam are available seven days per week for canoes and kayaks. The portage take-out is at the Barton Cove Canoe & Kayak Rental Area. Boaters wishing to proceed downriver of Barton Cove are picked up by the Licensee and driven to just downstream of the Project on Poplar Street in Montague City, where they can continue their trip. The Poplar Street Put-in is owned and maintained by the Licensee and is located at the end of Poplar Street. The site offers a small parking area and an informal access trail to the river.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

As stated in the PAD, the bulk of Task 1 of this study was conducted in 2012 and a brief summary of the results was included in Section 4.8.1. The winter portion of Task 1 was completed in 2013. As set forth, in Task 2,a summary of the results for all four seasons of investigation will be prepared.

Task 1: Study Preparation and Field Work

FirstLight developed and utilized a standardized survey form (See Figure 3.6.2-2) to evaluate each existing recreation facility to determine general condition and available amenities. Information that was gathered during the inventory included whether the site was accessible by water, vehicle, or foot; who owned and managed each site; whether it was formal or informal; the number and types of amenities, if the site was generally ADA compliant; if there was the potential of expansion; amount of available parking; observed activities; available services, and the general aesthetics of the site. The general condition of the site was observed by determining the need for major repairs to existing amenities and whether any safety concerns were noted. Staff also noted the existence of erosion along the Project shoreline associated with the existing sites. Photos of the site were taken and a GPS data point was recorded while in the field for each facility. Field staff traveled the Project area by vehicle and by boat to locate and observe the existing formal and informal sites. Once the work was completed this information was then entered into a GIS format.

Task 2: Summary Development

A summary of the results of the two studies will be prepared, along with maps of the recreation facility locations. The summary will detail the methods used to conduct the inventory and provide a description of each site which includes the available amenities and services; ownership and management; and a representative photo. A table showing ownership and management of each facility will also be included. The raw data will be included in an Appendix to the summary. FirstLight proposes to use this information in conjunction with Study No. 3.6.1 the *Recreation Use/User Contact Survey*, the *Whitewater Boating Evaluation* (Study No. 3.6.3), the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4), and the *Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use* (Study No. 3.6.7) to assess the sufficiency of existing recreational facilities. This information will also be included in the Recreation Management Plan.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The cost to complete the remaining portion of this study is estimated at $15,000-20,000. FirstLight believes that this is sufficient to fully meet the goals of this study.

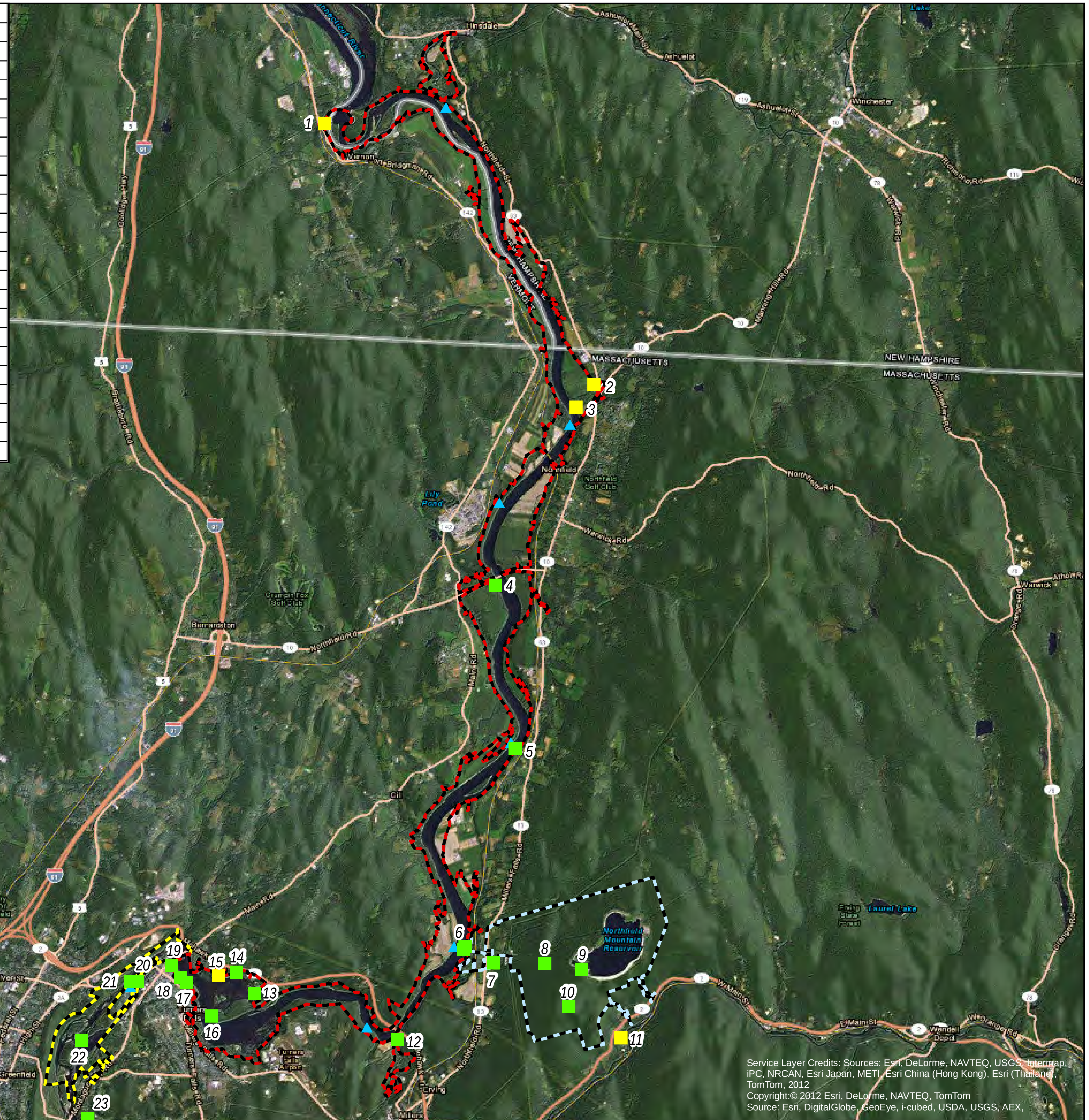
Study Schedule (18 CFR § 5.11(b)(2) and (c))

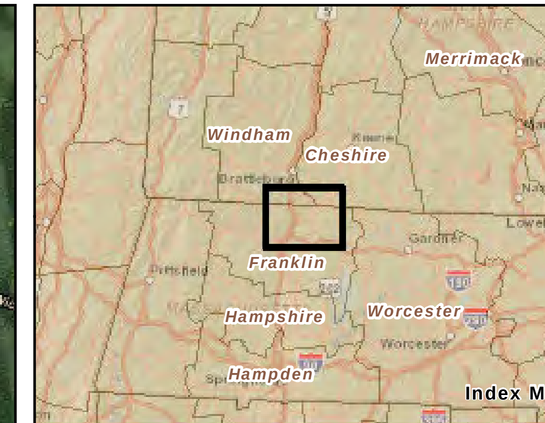
In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

As stated above, the bulk of this study was conducted in the summer of 2012 and a summary of the results was included in Section 4.8.1 of the PAD. The winter portion was completed in 2013 and a summary of the results for all four seasons of investigation will be prepared during the summer of 2013.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Site ID	Recreation Facility Name
1	Governor Hunt Boat Launch/Picnic Area
2	Pauchaug Wildlife Management Area
3	Pauchaug Boat Launch
4	Bennett Meadow Wildlife Management Area
5	Munn's Ferry Boat Camping Recreation Area
6	Northfield Mountain Boat Tour
7	Northfield Mountain Tour and Trail Center
8	Northfield Mountain Trail System
9	Northfield Mountain Mountaintop Observation Area
10	Rose Ledges
11	Farley Ledge
12	Cabot Camp
13	Barton Cove Nature Area
14	Barton Cove Canoe and Kayak Rental
15	MA State Boat Launch
16	Barton Cove Campground
17	Canalside Trial Bike Path
18	Unity Park
19	Turners Falls Fishway Viewing Area
20	Turners Falls Brank Canal Area
21	Turners Falls No. 1 Station Fishing Access
22	Cabot Woods Fishing Access
23	Turners Falls Canoe Portage





FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.6.2-1
Recreation Facilities Map

Legend

- Recreation Site Owned by FirstLight
- Recreation Site Owned by Others
- Informal Recreation Site
- Turners Falls Project Boundary
- Turners Falls\Northfield Mountain Project Boundary
- Northfield Mountain Project Boundary

N

0 0.75 1.5 3 Miles

1 inch = 1.5 miles

FirstLight Power Resources GDF SUEZ

Path: W:\gis\maps\Study_Plans\recreation\figure_3_6_2-1.mxd

Figure 3.6.2-2: Standardized Survey Form

Inspector:__________________ Date: ____________ Time: ___________ Photo No: ________

Project: _______________ Site Name/Code: _________________ Weather: ________________

Owner: ____ Telephone: _________________

Address: ____

City: _____________________ State: _____ Zip Code: ___________

Facility Type:

Campground____ Picnic Area____ Day Use/Overlook____ Informal____ Launch_____ Marina_____ Hiking______ Ski Area_______

Access:

_____ Water access
_____ Paved access _______ # of lanes
_____ Unpaved access (conventional motor vehicle) _______ # of lanes
_____ Unpaved access (4WD vehicle) _______ # of lanes
_____ ORV access (ATV) _______ width
_____ Foot access _______ width

Ownership/Management

	Licensee	Federal	State	County	Local	Private	Other
Ownership	_____	_____	_____	_____	_____	_____	__________
Management	_____	_____	_____	_____	_____	_____	___________

Operations:

Staffed ____ Private____ Seasonal_____ Commercial_____ Fee_____ Open/Closed ____

General Area:

Is the area associated with other facilities or activities?______________________________
Potential/need for expansion/enhancement? _______________________________________
Topography: __________________________ Ground cover: ________________________
Erosion/Soils: _________________________ Compaction: _________________________
Approximate Shoreline Footage: ___________ Bank Fishing (Yes/No):_______________
ADA compliant? Obstacles?________________ Rentals?_____________________________

Sanitation Facilities: (Yes/No)

Type:	Unisex	# of Units Women	# of Units Men	Notes (ADA, etc)
Flush	______	________	________	________________________
Composting	______	________	________	________________________
Vault	______	________	________	________________________
Pit	______	________	________	________________________
Portable	______	________	________	________________________
Wilderness	______	________	________	________________________

Site Facilities:

#	Type	Repairs	Material Code	Other Info
_____	Picnic Tables	________	_______	______________________________
_____	Grills	________	_______	______________________________
_____	Firepit/ring	________	_______	______________________________
_____	Trails (specify use)	________	_______	Length?_______________________
_____	Shelter	________	_______	______________________________
_____	Potable Water	________	_______	______________________________
_____	Dumping Station	________	_______	______________________________
_____	Boat Ramp	________	_______	______________________________
_____	Launching Lanes	________	_______	______________________________
_____	Playground	________	_______	______________________________
_____	Showers	________	_______	______________________________
_____	Benches	________	_______	______________________________
_____	Interpretive. Displays:	________	_______	______________________________
_____	Other: _________	________	_______	______________________________

Material codes; (A) asphalt, (B) Brick, (C) concrete, (CG) compacted gravel, (CRS) crushed gravel, (FE) metal, (G) grass, (GTF) geo-tech fabric, (NS) native soil, (O) other/specify, (P/F) plastic/fiberglass, (RC) rock crib, (S) sand, (W) wood.

Activities occurring:	# of Adults	# of Minors	Total # of users
Picnicking	_________	_________	_____________
Camping	_________	_________	_____________
Walking/hiking	_________	_________	_____________
Swimming	_________	_________	_____________
Beach Activities	_________	_________	_____________
Launching boats	_________	_________	_____________
Fishing	_________	_________	_____________
________________	_________	_________	_____________

Parking Lots:		Surface Code	Dimensions
# ADA spaces	_________	_________	_________
# regular spaces	_________	_________	_________
# Vehicle & trailer spaces	_________	_________	_________
# of vehicles in lot	_________	Space delineated_________	Curbs_________

Beach/Swim Area: (Yes/No)

	Number	Dimensions	Material	ADA Compliant
Dock/Pier:	________	_______	______	_______
Float: :	________	_______	______	_______

Beach Area Substrate: _________________________ Swim Area Substrate: _________________

Dimensions of beach: ________________ Lifeguards ______ Buoyed swim area ________

Campground/Campsite:

	RV sites	Cabin sites	Tent sites	Wilderness sites
Group Sites	________	________	________	________
Access (foot, orv, car, boat)	________	________	________	________
# of sites	________	________	________	________
On site parking	________	________	________	________
Water front	________	________	________	________
ADA compliant	________	________	________	________
Utilities	________	________	________	________

* (E) Electric, (S) Sanitation, (W) Water, (O) other (specify)

Boat Launch Facilities:

Hard surface _____ Gravel _____ Unimproved _____ Carry In _____ Launch/Load prep area: _____

Docks/Piers/Floats Total Docks____________ Total Slips _____________

Material code:	#1______	#2______	#3______	#4______	#5______
Dimensions:	#1______	#2______	#3______	#4______	#5______
# of slips:	#1______	#2______	#3______	#4______	#5______
ADA compliant:	#1______	#2______	#3______	#4______	#5______

Fishing Piers:

Number: __________________ Combined Length of Piers_______________
Surface code: _________________ ADA compliant: ______________________

Site Aesthetics:

Viewshed from site: __________ Viewshed from shoreline: ____________

1 – No noticeable development
2 – Very limited primitive development
3 – Five (5) or less buildings in view
4 – Six (6) to ten (10) buildings in view
5 – Ten (10) or more buildings in view
6 – Highly developed

Nature of abutting development/land use: ____

Audio perceptions from site: ____

Audio perceptions from shoreline: ____

Evidence of use at site: _____________________________

*(C) Compaction, (E) Erosion, (G) Garbage, (GD) Ground disturbance, (HW) Human waste, (UI) Unauthorized improvements, (V) Vandalism, (VR) Vegetation removal, (O) Other (Specify)

Evidence of Overcrowding: _________________________
*(A) Anecdotal information, (FA) facility/amenity @ capacity, (I) Improper parking, (S) Signage, (SD) site degradation, (U) Unauthorized sites, (W) Waiting lines, (O) Other (Specify)

Notes: ____

Sketch:

3.6.3 Whitewater Boating Evaluation

General Description of Proposed Study

FERC, NEF, AMC, AWWA, NPS, VRC and FCRP submitted requests for a controlled flow whitewater boating analysis on various dates in the spring (for moderate and high flows) and in the summer (for potential scheduled lower flow releases) of the Turners Falls bypass reach. All the requests were similar and requested FirstLight to use accepted whitewater boating evaluation practices to assess the presence, quality, and preferred flow ranges for river based boating resources in the Turners Falls bypass reach. FERC also requested that competing recreational uses and resource needs that may be adversely impacted by any scheduled releases be identified. NEF, AMC, AWWA, NPS, VRC and FCRP also request that access needs for put-in and take-out along the bypass reach be identified and a flow information and distribution system be assessed. FirstLight is proposing to develop and conduct a controlled whitewater boating analysis of the Turners Falls bypass using accepted comparative evaluation practices. FirstLight will consult with stakeholders to develop a comparison flow study methodology, determine the number of flows and volumes to be evaluated, schedule the timing of the evaluation, and to enlist a group of experienced boaters to participate in the evaluation. ~~NEF, AMC and AWWA request that the flow assessment occur on various dates in the spring (for moderate and high flows) and in the summer (for potential scheduled lower flow releases)~~. ~~FirstLight is not proposing to conduct whitewater boating evaluations in the spring because the only known spawning and rearing areas for ESA-listed shortnose sturgeon in the Connecticut River are located in the bypass reach and whitewater flow releases have a potential to interrupt spawning or flush eggs and larvae from the rearing area.. In addition, FirstLight does not propose to conduct a spring evaluation because of the possibility of unreliable results due to the lag time between spring and summer evaluations. Because a component of the boating evaluation will be a comparative rating and analysis of several flows, FirstLight is proposing that the on-water boating evaluation be conducted on consecutive days in one season to ensure consistency in assessing and comparing the various flows and in the make-up of the flow evaluation team.~~

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The objectives of the study are:

- Assess the effects of a range of bypassed reach flows on whitewater recreation opportunities;
- Determine what watercraft-types would be appropriate to utilize any potential whitewater flows in the bypassed reach;
- Determine the range of flows (minimum through optimal) needed to support various whitewater boating opportunities by watercraft;
- Determine whether current or future demand exists for whitewater boating in the bypassed reach;
- Determine the number of days per month the acceptable and optimum flows for whitewater boating would be available under the Turners Falls Project’s current and any proposed mode of operation;
- Determine any competing recreational uses or other resource needs that may be adversely affected by whitewater boating;
- Identify the need for and define adequate access points, if needed, that provide trails and car-top parking at Great Falls Discovery Center, Station #1 and Cabot Station, and egress at the end of the 2.7 mile bypass run at the confluence of the Deerfield River;
- Conduct an assessment of existing regional whitewater boating opportunities; and

- Prepare a study report that describes the: whitewater boating attributes of the range of flows examined, including level of difficulty, portage requirements; identifies the acceptable and optimal flows for the reach and the frequency of availability of the identified flows under current and any proposed project operation; incorporates relevant results from the *Recreation Use/User Contact Survey* (Study No. 3.6.1), the *Recreation Facilities Inventory and Assessment* (Study No. 3.6.2), and the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4) including characterization of the suitability of the bypassed reach for whitewater boating, annual recreation use by activity and season of the bypassed reach; whether or not there is a demand for whitewater boating in the bypassed reach; and any competing recreation uses or other resources in the bypassed reach that could be adversely affected by providing flows for whitewater boating.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the presence and operation of the Turners Falls and Northfield Mountains Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

There is limited information on whitewater boating flows associated with the Turners Falls bypass. The Appalachian Mountain Club *AMC River Guide, Massachusetts, Connecticut, Rhode Island*, Fourth Edition (2006) states there is very little water in the bypass reach except during flood conditions when canoeing is not advised, and that the 3.5 miles of river below the Turners Falls Dam cannot be run even by experienced canoeists.

Anecdotal information indicates that whitewater features exist during high flow conditions in the bypass near the river bend just downstream of Turners Falls Dam and at the so-called "rock dam" located approximately 1.8 miles downstream of the dam, and that the remainder of the bypass is fast current.

Need for Additional Information:

To determine if flows in the bypass area can provide whitewater boating opportunities, a variable flow evaluation will need to be conducted.

Project Nexus (18 CFR § 5.11(d)(4))

FERC policy requires licensees to provide reasonable public recreation opportunities consistent with the safe and effective operation of the Project.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1 – Develop Boating Evaluation Protocol, Logistics and Schedule

Working with NEF, AWWA and AMC, and other interested stakeholders, FirstLight will coordinate selecting dates for spring boating evaluations utilizing natural bypass flows (approximately two flows) and summer bypass evaluations utilizing controlled flows (approximately four flows), scheduling of the evaluations, assembling a team of volunteer boaters (approximately 24 boaters of variable skill levels and with a variety of watercraft, including "tubers"), field logistics, and developing a methodology and comparative evaluation process to rate the bypass flows to meet the study objectives (see Figure 3.6.3-1 for draft evaluation forms). FirstLight will inspect the bypass reach for the presence of rebar in areas subject to flows, and if found, remove the rebar prior to the boating evaluation.

Task 2 – On-Water Boating Evaluation

The boating evaluation will be conducted as designed in Task 1. Two spring dates will be scheduled approximately two weeks apart to evaluate typical spring flows in the bypass. FirstLight will review historical bypass spring flow data and in coordination with NEF, AWWA and AMC based on this data, and schedule dates for the spring evaluations. Participating boaters will complete an evaluation form for each spring flow and a comparative summary evaluation for the two flows after the second boating run. FirstLight will lead and record a post evaluation discussion to discuss the study and to gather additional feedback from the participants.

The summer flows to be evaluated will be established prior to the field evaluations, though flows may be adjusted based on participant boater recommendations during the evaluation provided any adjusted flow(s) can be calibrated at Turners Falls Dam. Participating boaters will complete an evaluation form after each flow and a comparative summary evaluation for all flows upon completion of the final boating run. FirstLight will lead and record a post evaluation discussion to discuss the study and to gather additional feedback from the participants.

Task 3 – Identify and Evaluate Access to the Turners Falls Bypass Reach

FirstLight will identify, investigate, and assess access points that provide trails and car-top parking along the bypass reach including the Great Falls Discovery Center, Station #1, Cabot Station, and at the end of the 2.7 mile bypass run at the confluence of the Deerfield River. This work may be conducted as part of the *Recreation Use/User Contact Survey* (Study No. 3.6.1).

Task 4 – Data Review and Analysis

Historic flow data will be analyzed to determine the number of days per month spring and summer flows for whitewater boating, as determined by the results of the controlled flow analysis, would be available under the Turner's Falls Project's current mode of operation. An analysis will also be conducted to determine the number and timing of boatable flows for any proposed mode of operation at Turners Falls.

FirstLight will assess whether current or future demand exists for whitewater boating in the bypassed reach using data from the controlled flow analysis, the *Recreation Use/User Contact Survey* (Study No. 3.6.1), an assessment of existing regional whitewater boating opportunities, and regional projections for changes for paddle boating.

Based on existing data and data collected from other relicensing studies related to the Turners Falls bypass, FirstLight will identify any competing recreational uses or other resource needs that may be adversely affected by any scheduled releases for boating.

Task 5 – Report Development

The information gathered during these efforts will be included in a study report addressing the study goals and objectives identified above.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain data to determine the level of whitewater boating opportunities, which may be available with releases in the Turners Falls bypass. The estimated cost for the whitewater boating evaluation outlined in this plan is approximately $60,000 to $65,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. Prior to the filing of the RSP, FirstLight will hold an additional meeting with stakeholders to review and obtain comments on the proposed survey instrument contained herein. The Whitewater Boating Evaluation will be conducted in 2014 as follows: develop, and finalize protocols, logistics, and evaluation schedule in winter 2013/2014, conduct spring flow evaluations in April/May 2014, and conduct summer flow and access evaluation in July/August 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Figure 3.6.3-1a: Pre-Run Boater Information Form

PRE-RUN BOATER INFORMATION FORM
Turners Falls Hydroelectric Project, FERC No. 1899
Whitewater Controlled Flow Study

Date:____________________________, 2014

Name:____

1. What type of watercraft do you generally use for whitewater paddling? *(Circle one)*
   - Hard shell kayak
   - Inflatable kayak
   - Closed deck canoe
   - Open canoe
   - Tube
   - Cataraft (please indicate length:__________)
   - Raft (please indicate length:______________)
   - Other: (please explain)___________________

2. How many years have you been using this type of watercraft? ________ Years

3. How would you rate your skill level with this type of watercraft? *(Circle one – whitewater classifications defined on next page)*

   Novice (comfortable running Class II whitewater)
   Intermediate (comfortable running Class III whitewater)
   Advanced (comfortable running Class IV-V whitewater)
   Expert (comfortable running Class V whitewater)

4. In general, how many days per year do you spend whitewater boating? ____________________

5. What is your age? _______

6. Are you □ male or □ female?

7. Have you boated the by-pass area between Turners Falls Dam and Cabot Station on the Connecticut River before? Yes______ No______

Please respond to each of the following statements about your river-running preferences.

	Strongly disagree	Moderately disagree	Slightly disagree	No Opinion	Slightly agree	Moderately agree	Strongly agree
I prefer running rivers with Class II and III rapids.	1	2	3	4	5	6	7
I prefer running rivers with difficult rapids (Class IV-V).	1	2	3	4	5	6	7

	Strongly disagree	Moderately disagree	Slightly disagree	No Opinion	Slightly agree	Moderately agree	Strongly agree
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5	6	7
I often boat short river sections (under 4 miles) to take advantage of whitewater play areas.	1	2	3	4	5	6	7
I often boat river segments to experience a unique and interesting place.	1	2	3	4	5	6	7
I often boat short river segments to run challenging rapids.	1	2	3	4	5	6	7
I select boating opportunities based on length and experience regardless of difficulty.	1	2	3	4	5	6	7
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	1	2	3	4	5	6	7
I prefer boating rivers that feature large waves and powerful hydraulics.	1	2	3	4	5	6	7
I prefer boating steep technical rivers.	1	2	3	4	5	6	7
I enjoy boating both difficult and easy rivers.	1	2	3	4	5	6	7

Class I – Fast moving water with riffles and small waves. Few obstructions, all obvious and easily missed with little training. Risk to swimmers is slight; self-rescue is easy.

Class II – Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium-sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful, is seldom needed.

Class III – Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. Complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. Strong eddies and powerful current effects can be found, particularly on large-volume rivers. Scouting is advisable for inexperienced parties. Injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims.

Class IV – Intense, powerful but predictable rapids requiring precise boat handling in turbulent water. Depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. A fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. Rapids may require "must" moves above dangerous hazards. Scouting may be necessary the first time down. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong eskimo roll is highly recommended.

Class V – Extremely long, obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end of the scale, several of these factors may be combined. Scouting is recommended but may be difficult. Swims are dangerous, and rescue is often difficult even for experts. A very reliable eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential.

Figure 3.6.3-1b: Single Flow Evaluation Form

SINGLE FLOW EVALUATION FORM
Turners Falls Hydroelectric Project FERC No. 1889
Whitewater Controlled Flow Study

Date of run: ____________________

Name: ____

Indicate which flow release this survey corresponds to (check appropriate box):

Flow 1	X cfs	Date/time	
Flow 2	X cfs	Date/time	
Flow 3	X cfs	Date/time	
Flow 4	X cfs	Date/time	

1. Watercraft used (Circle appropriate one):

Hard shell kayak
Inflatable kayak
OC1
OC2
C1
C2
Raft
Cataraft
Tube
Other (describe):_______________

2. Your whitewater boating skill level for the watercraft used for this flow (Circle appropriate one):

Beginner
Novice
Intermediate
Advanced
Expert

3. Please evaluate the boating access for this segment of river (Circle appropriate one):

Put-in Access: easy moderate difficult

Take-out Access: easy moderate difficult

4. Please evaluate this flow for your craft and skill level for each of the following characteristics (Circle one number for each characteristic).

If unacceptable, was flow:

	Totally unacceptable	Unacceptable	Neutral	Acceptable	Totally acceptable	Too Low	Too high
Navigability	-2	-1	0	1	2		
Availability of challenging technical boating	-2	-1	0	1	2		
Availability of powerful	-2	-1	0	1	2		

	Totally unacceptable	Unacceptable	Neutral	Acceptable	Totally acceptable	Too Low	Too high
hydraulics							
Availability of whitewater play areas	-2	-1	0	1	2		
Overall whitewater challenge	-2	-1	0	1	2		
Safety	-2	-1	0	1	2		
Aesthetics	-2	-1	0	1	2		
Length of run	-2	-1	0	1	2		
Number of portages	-2	-1	0	1	2		
Overall Rating	-2	-1	0	1	2		

5. Are you likely to return for future boating in the Turners Falls bypass at **this** flow? (Circle one)

   Definitely no　　Possibly　　Probably　　Definitely yes

6. Based on the International Whitewater Scale, how would you rate the whitewater difficulty of the river at **this** flow? (Circle one)

   - Class I – Fast moving water with riffles and small waves. Few obstructions, all obvious and easily missed with little training. Risk to swimmers is slight; self-rescue is easy.

   - Class II – Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium-sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful is seldom needed.

   - Class III – Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. Complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. Strong eddies and powerful current effects can be found, particularly on large-volume rivers. Scouting is advisable for inexperienced parties. Injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims.

   - Class IV – Intense, powerful but predictable rapids requiring precise boat handling in turbulent water. Depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. A fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. Rapids may require "must" moves above dangerous hazards. Scouting may be necessary the first time down. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong eskimo roll is highly recommended.

- Class V – Extremely long, obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end of the scale, several of these factors may be combined. Scouting is recommended but may be difficult. Swims are dangerous, and rescue is often difficult even for experts. A very reliable eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential.

7. What skill level does a paddler need to safely paddle the bypass at **this** flow? (Circle one)

Beginner	Advanced
Novice	Expert
Intermediate	

8. Relative to **this** flow, would you consider the **minimum** acceptable flow (defined as the lowest flow you would return to boat) to be higher, lower, or about the same as this flow? Circle one

Much lower	Higher
Lower	Much higher
No change	

9. Relative to **this** flow, would you consider the **optimum** flow (defined as the ideal flow you would return to boat) to be higher, lower, or about the same as **this** flow? Circle one

Much lower	Higher
Lower	Much higher
No change	

10. Using place names or locations, please identify challenging rapids or sections and rate their difficulty (using the International Whitewater Scale at **this** flow).

Place name/Locations	Rating
____	_____
____	_____

11. Estimate the number of hits, stops, boat drags, and portages you had at **this** flow.

Number of hits (but did not stop)	_____
Number of hits with stops (did not have to get out of boat)	_____
Number of hits with stops (had to get out of boat to continue)	_____

Number of portages ______

12. Using place names/locations on the map provided, identify rapids or sections you portaged and the rate the difficulty of the portages (for **your** type of watercraft at **this** flow)

Place name/location and reason for portage	Easy	Slightly Difficult	Moderately Difficult	Extremely Difficult
______________________________	1	2	3	4
______________________________	1	2	3	4
______________________________	1	2	3	4

13. Did you experience any difficulties during your run **at this flow** (e.g., pinned, wrapped a boat, swam, etc.)? Provide a brief description and location of any difficulty.

Incident	Location
______________________________________	____________________
______________________________________	____________________
______________________________________	____________________

14. Provide any additional comments about **this** flow below. If necessary, please use place names/locations to identify specific locations.

Figure 3.6.3-1c: Single Flow Evaluation Form

COMPARATIVE FLOW EVALUATION FORM
Turners Falls Hydroelectric Project FERC No. 1889
Whitewater Controlled Flow Study

Date: ______________________________, 2014

Name: ____

1. Watercraft used (Circle appropriate one):

   Hard shell kayak
   Inflatable kayak
   OC1
   OC2
   C1
   C2
   Raft
   Cataraft
   Tube
   Other (describe):___________________

2. Your whitewater boating skill level (Circle one):
   Beginner
   Novice
   Intermediate
   Advanced
   Expert

3. Did you participate in all four boating releases? Yes______ No______

Please answer each of the following questions based on your experience or reaction to the river at each of the flows boated. If you have no opinion about a particular item, leave it blank. Please do not discuss these questions or your responses with other participants.

4. How many times have you boated the Turners Falls bypass of the Connecticut River before this study? (Circle one)

   0 times 1-5 times 6-10 times 11-20 times >20 times

5. A number of factors can affect one's satisfaction with a whitewater trip. How important are each of these factors to you? (Circle one number for each factor)

	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Number of rapids	1	2	3	4	5
Size/difficulty of rapids	1	2	3	4	5
Driving distance to river	1	2	3	4	5
Accessibility	1	2	3	4	5

	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Shuttle Availability	1	2	3	4	5
Crowding	1	2	3	4	5
Weather	1	2	3	4	5
Water temperature	1	2	3	4	5
Attractive scenery	1	2	3	4	5
Water quality	1	2	3	4	5
Thrilling experience	1	2	3	4	5
Safe trip	1	2	3	4	5

6. Evaluate the following flows for your craft and skill level. In making your evaluations, consider all the flow-dependent characteristics that contribute to a high quality trip (e.g., navigability, whitewater challenge, safety, availability of surfing and other play areas, aesthetics, and length of run). If you did not boat a particular flow(s) during the evaluation, do not rate that flow.

Release Date/Time	Flow (CFS)	Totally Unacceptable	Unacceptable	Neutral	Acceptable	Totally Acceptable
		-2	-1	0	1	2
		-2	-1	0	1	2
		-2	-1	0	1	2
		-2	-1	0	1	2

7. Based on your boating runs on this section of the Connecticut River as part of this study, specify the flows that provide the following types of experiences. (Note: you can specify flows that you did not run/observe, but which you think would provide the type of experience in question).

Flow (cfs)

- From a recreational perspective what is the **minimum acceptable flow** for this run? Note that minimum acceptable differs from minimum flow necessary to navigate. _________
- From your perspective, what is the **optimum flow** for this run? _________

8. Rate the flows evaluated in terms of your craft and skill level

FLOW	CFS	Acceptable	Neutral	Unacceptable
1 (Date/time)				

2 (Date/time)				
3 (Date/time)				
4 (Date/time)				

9. How important is it to have a variety of flows in the Turners Falls bypass section of the Connecticut River? Rate the importance of having variable flows for the reasons below, or check the box below the table.

A variety of flows is necessary to:	Not at all important	Slightly important	Moderately important	Very important	Extremely important
provide different types of boating experiences;	1	2	3	4	5
provide opportunities for people with different skill levels and watercraft;	1	2	3	4	5

or, □ it isn't important to provide a variety of flow levels for boating.

10. Compared to other rivers, how would you rate the boating opportunities on the Turners Falls bypass section of the Connecticut River? (Circle appropriate response for each region. If you are unsure about a comparison, leave that item blank.)

Compared to:	Worse than average	Average	Better than average	Excellent	Among the very best
Other rivers within a 1 hour drive					
Other rivers in Massachusetts					
Other rivers in the northeast					
Other rivers in the country					

11. Based on your experience at other regional rivers, use the following scoring system to compare the boating opportunities at these regional rivers to those of the Turners Falls bypass section of the Connecticut River. Assume optimal flow conditions for boating.

Score using the following system:

1 = More desirable than Turners Falls bypass section of the Connecticut
2 = Similar to the Turners Falls bypass section of the Connecticut
3 = Less desirable than the Turners Falls bypass section of the Connecticut
4 = No experience boating the river

	Millers	Tully	Farmington	Deerfield	Eight Mile	Cold	Green	Chicopee	Ware	Swift	Nepaug	Salmon	Blackledge	Jeremy
Suitable for novice boater														
Suitable for intermediate boater														
Suitable for advanced boater														
Size & difficulty of rapids														
Play boating														
Rafting														
Tubing														
Canoeing														
Kayaking														
Eddy hopping														
Technical maneuvering														
River gradient														
Driving distance to river														
Shuttles														
Access to river														
Parking														
Scenery														
Water quality														
Overall														

12. Any other comments?

3.6.4 Assessment of Day Use and Overnight Facilities Associated with Non-motorized Boats

General Description of Proposed Study

A number of stakeholders requested this study including NPS, AMC, VRC, FCRP, NEF, AWWA, and CRWC. As part of its request for a study of project facilities to support multiple-day self-powered boating trips, NPS/AMC et al request a survey of people who do not use the river or are displaced. FirstLight has proposed to conduct a study of recreation use at the Northfield Mountain Project but does not propose to conduct a survey of non-users or displaced users. It is difficult to identify with any degree of precision the scope of non-users and displaced users and target these groups for a survey. A regional blanket mail survey (to some portion of the populations) to reach these users requires a significant level of effort that is not justified by the typical low rate of return when considering the ratio of non-users and displaced users in relation to the population sampled. In sum, the survey may not provide a statistically valid sample size. FERC regulations require the Licensee to provide an estimate of existing and potential recreational use of the project area as well as measures for creating, preserving and enhancing recreational opportunities at the project. The proposed study plans use standard, FERC- accepted methodologies including a review of the existing day use and overnight facilities associated with carry-in boat launching and water-access camping within the Turners Falls and Northfield Mountain Projects.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of the study are:

- Determine the number of overnight recreation facilities located within the Projects and along both sides of the shoreline down to the Sunderland Bridge including the number, capacity, and types of amenities available;
- Determine the need for and if alternate canoe portage trails are feasible;
- Determine the need for and possible locations for future carry-in boat facilities (particularly at Turners Falls Dam, Station #1, Cabot Station, and the Deerfield River Confluence) and overnight facilities;
- Determine if current facilities are adequately spaced for non-motorized boating day use trips;
- Determine if improvements are necessary at existing facilities to meet current and near future use particularly at put-in and take-out facilities; and
- Determine if the seasons of operation are consistent with actual river use.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the presence and operation of the Turners Falls Project.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

Boating, camping, and canoeing use currently occurs within the Projects. The Connecticut River National Blueway, which encompasses the river and its 7.2 million-acre watershed includes Project lands and waters. The AMC River Guide and the Connecticut River Boating Guide: Source to Sea (3^{rd} ed.) describe the Connecticut River between the Vernon Falls Dam and the Turners Falls Dam as a flat water to quick water paddle with overnight camping available at Munn's Ferry and Barton Cove Campground.

There are multiple recreation facilities within the Projects' boundaries that offer a variety of recreation opportunities to the boating community, including the following existing facilities.

Barton Cove Nature Area and Campground: This Nature Area is located within the Turners Falls and Northfield Mountain Projects, on Barton Cove Road in Gill, MA. The Nature Area is owned and managed by the Licensee and is open to the public for camping, picnicking, and bank fishing. Campsites have a picnic table, fire ring and garbage can. There are two vault toilets and additional portable restrooms located within the campground. There is water access from some of the sites and bank fishing is permitted.

MA State Boat Launch: This launch is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the state of Massachusetts, and is open to the public. The site offers boat launching and bank fishing opportunities. There is a parking lot, boat ramp, dock, and portable sanitation facility.

Barton Cove Canoe and Kayak Rental Area: This site is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the Licensee and offers day use opportunities. There is a canoe/kayak launch, a rental office, picnic tables, parking, and a portable sanitation facility.

Munn's Ferry Boat Camping Recreation Area: This site is a water access site located on the east side of the river in Northfield, MA. The camping area is located within the Turners Falls and Northfield Mountain Projects. This area is owned and managed by the Licensee and is available for overnight use. There are tent campsites each with a trash can, tent platform, picnic table, fire ring and grill. There is also a lean-to site with a trash can, tent platform, picnic table, fire ring and grill. There are pit toilets available at the site. Bank fishing opportunities are also available at this site.

Pauchaug Boat Launch: This site is owned and managed by the state of Massachusetts. The site is located within the Turners Falls Project and Northfield Mountain Project. There is a boat launch, parking and portable sanitation available at this site.

Governor Hunt Boat Launch/Picnic Area: This site is owned and managed by TransCanada, which owns the Vernon Project. While this area is within the Vernon Project boundary, the area is also located in the area where the Turners Falls Project and Northfield Mountain Project boundaries and the Vernon Project boundary overlap. The area is open for day use opportunities and has a picnic area and boat launch. Recreation opportunities at the site include bank fishing, picnicking, boat launching, and sightseeing.

Turners Falls Canoe Portage (Poplar Street Put-in): Portages around the Turners Falls Dam are available seven days per week for canoes and kayaks. The portage take-out is at the Barton Cove Canoe & Kayak Rental Area. Boaters wishing to proceed downriver of Barton Cove are picked up by the Licensee and driven downstream to Poplar Street in Montague, where they can continue their trip. The Poplar Street put-in is owned and maintained by the Licensee and is located at the end of Poplar Street. The site, which offers a small parking area and an informal access trail to the river, is located outside of the Turners Falls Project boundary.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of Project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Literature Review:

FirstLight proposes to conduct a desk top review of the existing recreation data including recreation facility inventory data collected in 2012-2013 and camping records. This information will be used to determine the locations and spacing between facilities associated with non-motorized boating trips, as well as hours and seasons of operations. Data regarding existing capacity and existing campsite use will be compared to determine if the current facilities are meeting current use needs.

The Licensee will review and take into consideration appropriate federal, state, county and local programs and plans related to recreational use of the waterway within the Projects' boundaries. These plans will include a review of the Connecticut River Paddlers Trail organization's maps and plans, along with the AMC River Guide and the Connecticut River Boating Guide: Source to Sea (3rd ed.). The Licensee will consult with the CT River Paddlers Trail organization about the current work that it is conducting with regard to the location of campsites, put-ins and take-outs on the river within the Project vicinity for overnight non-motorized boating.

Data from the *Recreation Use/User Contact Survey* will be reviewed to assess the need for new or improved facilities to accommodate non-motorized boating use at the Projects. FirstLight will also review land ownership information, existing improvement plans, and aerial photography to determine potential locations for future use sites, if needed and potential improvements for existing sites, if needed.

The Licensee will review traffic direction, road widths, general amount of road use, public safety, property ownership, topography, estimation of construction costs, river flows, and trail lengths when considering potential canoe portage trails. Information will be field verified and updated as appropriate as part of Task 2.

Task 2: Field Work

A field survey will be used to ground verify the location for potential future use sites and determine the feasibility of developing these sites. Areas that will be visited may include Kidd's Island, Munns Ferry, and other lands as identified by Task 1 or as observed in the field. A review of potential canoe portage trails will also be conducted in the field along with flows at potential put-in locations. FirstLight will observe water flows and depths in the by-pass to determine navigability by non-motorized boats.

Task 3: Report Preparation

Upon completion of field surveys, FirstLight will use the data reviewed and gathered to develop a written report discussing the findings including the sufficiency of current recreation facilities and need, if any, for new or improved facilities and potential improvements with respect to multiple day non-motorized boat trips. A map depicting the current locations of facilities and potential future locations will also be included as part of the report. A table showing ownership and management of existing and potential sites along with the facility type and number of overnight sites will be provided in the report.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain information regarding carry-in boating opportunities within the Turners Falls Project area. The estimated cost for the assessment outlined in this plan is approximately $ 40,000- 45,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

The literature review will conducted in January – April of 2014, while field work will be completed between May and August of 2014. Report preparation will occur at the end of 2014 and in the beginning of 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.6.5 Land Use Inventory

General Description of Proposed Study

This study was proposed by FirstLight as part of the PAD and includes a review of existing land uses occurring on Project and adjacent lands, applicable land use controls such as local zoning, results of other resource studies, and a determination of the appropriate land use designations for lands within the Turners Falls Project and Northfield Mountain Project. Once the existing land uses and land use controls are identified, FirstLight will review available aerial photography and apply an appropriate designation to the Turners Falls Project and Northfield Mountain Project lands. This will aid in future land management decisions for lands within the Turners Falls Project and Northfield Mountain Project boundaries.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of this inventory are as follows:

- Identify the current land uses within the Turners Falls Project boundary and the Northfield Mountain Project boundary.
- Identify the current land uses on lands abutting the Turners Falls and Northfield Mountain Project boundaries up to 200 feet.
- Identify current land use controls on lands within the Projects' boundaries and on lands abutting the Project boundaries up to 200 feet.
- Determine the appropriate land use designations for lands within the Turners Falls Project and Northfield Mountain Project boundaries. Designations will be based on the review of existing uses on lands within the Projects' boundaries and adjacent lands, the results of other resource studies, and land use controls such as local zoning.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Resource management agencies are interested in the appropriate land designations in order to protect the natural resources within the Northfield and Turners Falls Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information

Section 4.8 of the PAD provided information regarding recreation resources within the Projects and surrounding areas. Lands within the Projects' boundaries are used for operation of the Projects and recreation. There are also areas of agricultural and forested lands, as well as wetland areas located within the Projects. Other land types located within the Projects include open land, medium, low, and very low density residential development, forest, wetlands, open land, powerline/utility, urban, public/institutional, and industrial uses. Associated land use activities also include land maintenance, road and trail maintenance, tree removal, and vegetation clearing. The area surrounding the Turners Falls and Northfield Mountain Projects, from the Northfield Mountain Project north to the Vernon Project, is largely rural with a mix of agriculture lands and some forested areas. The lands south of the Northfield Mountain Project, near the Turners Falls Dam, are largely developed with a mix of residential and industrial uses. There are no Vermont, Massachusetts, or New Hampshire designated natural areas within the Turners Falls and Northfield Mountain Projects' boundaries.

The Licensee has granted permission to others for non-Project uses of Project lands in accordance with the provisions of the Turners Falls and Northfield Projects' licenses. These non-Project uses include uses of Project lands and waters for a parking area, the Conte Fish Lab, a fire pond, a privately owned boat club, private camps, landscaping activities, agricultural uses, communications antennas, docks, a NPDES discharge, and water withdrawals.

Need for Additional Information:

FirstLight will continue to make land management decisions regarding the use of lands within the Projects. In order to guide in decision making for future use of lands within the Projects' boundaries, FirstLight requires updated land use information regarding the current uses of Project lands and of lands within 200 feet of the Projects' boundaries. This information can then be used to determine appropriate land use designations for lands within the Projects' boundaries. The information would be readily available via GIS mapping and can be continually updated as information changes.

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and the Northfield Mountain Project may have the potential to affect land use within the Projects' boundaries.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Literature and Aerial Photography Review

FirstLight proposes to review existing land use controls, because land use controls may impact how land is currently being used. Information reviewed will include local plans, ordinances, statutes, policies, and guidelines that may affect use and/or management of Project lands, along with the results of resource studies conducted as part of the relicensing process. Examples of information that will be reviewed include but are not be limited to the MA River Protection Act, data from the MA GIS database, the 2005 Northfield Open Space and Recreation Plan, 2005 Gill Open Space and Recreation Plan, 2010 Montague Open Space and Recreation Plan, Erving Master Plan, and Sustainable Franklin County – A Regional Plan for Sustainable Development for Franklin County. The Licensee will also review and identify conservation easements within 200' of the Turners Falls and Northfield Mountain Project boundaries to the extent that such information is readily available.

Using aerial photography, FirstLight will also identify land uses and land use controls on lands abutting the Projects up to 200 feet beyond the Projects' boundaries. Identification of uses of lands within 200 feet of the Projects' boundaries will allow for appropriate designation of lands within the Projects taking into consideration abutting property use. This review will utilize existing, publicly available aerial photography and will be ground truthed as necessary.

Task 2: Development and Application of Land Use Designations

FirstLight will use the results of the literature review and the results of the identification of land uses currently occurring within the Projects' boundaries and on adjacent lands to develop appropriate land use designations for lands within the Projects' boundaries. Proposed land use designations may include:

agriculture – crop, agriculture – livestock, residential, recreation, industrial, wetlands, and forested. These land use designations may be refined once photo interpretation begins and based on a review of designations used in plans reviewed as part of Task 1. Once land use designations are defined, FirstLight will propose the application of the appropriate designation to lands within the Turners Falls Project and Northfield Mountain Project boundaries.

Task 3: Map and Summary Development

FirstLight will prepare maps and a summary of the results of the inventory. The summary will include the proposed land use designations and definitions, along with the percentage of Project lands in each designation.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is adequate to obtain baseline information on the existing land uses and land use controls within the Project boundaries and on abutting lands up to 200 feet from the Project boundaries. The estimated cost for this inventory is approximately $15,000-20,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. The *Land Use Inventory* will be initiated in 2014 but because the *Inventory* depends in part on the results of other resources studies proposed herein, the *Inventory* will be completed in 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.6.6 Assessment of Effects of Project Operation on Recreation and Land Use

General Description of Proposed Study

FirstLight originally proposed this study in the PAD. The study plans to use the information derived from the studies set forth in the Recreation Use/User Contact Survey and the Recreation Facilities Inventory and Assessment to assess the potential impact of continuing operation and maintenance of the Projects on recreation and land use.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objective of this assessment is to determine if the operation of the Turners Falls Project and the Northfield Mountain Project has an effect on the recreation facilities or land use within either Project.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the operation of the Turners Falls and Northfield Mountains Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

There are 20 formal recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. Section 4.8 of the PAD provided information regarding recreation resources within the Projects and surrounding areas. These facilities provide a variety of amenities, including but not limited to boat ramps, camp sites, picnic tables, benches, trails, and interpretive displays.

Need for Additional Information:

FirstLight will need to review the proposed studies, once completed, to determine if there are effects from Project operations on the existing public recreation sites or on land use within either Project and down to the Sunderland Bridge.

Project Nexus (18 CFR § 5.11(d)(4))

The objective of this assessment is to determine if the operation of the Turners Falls Project and the Northfield Mountain Project has an effect on the recreation facilities or land use within either Project and down to the Sunderland Bridge.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Data Compilation

FirstLight will review the information derived from the studies set forth in the *Recreation Use/User Contact Survey* (Study No. 3.6.1), the *Recreation Facilities Inventory and Assessment* (Study No. 3.6.2), the *Whitewater Boating Evaluation* (Study No. 3.6.3), the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4), and the *Recreation Study at Northfield*

Mountain, including Assessment of Sufficiency of Trails for Shared Use (Study No. 3.6.7) to assess the potential impact of continuing operation and maintenance of the Projects' on recreation. FirstLight will also review historic and existing water level fluctuation information.

Task 2: Data Analysis

FirstLight will compare the information reviewed in Task 1 to determine if there are access issues resulting from water level fluctuations, including any potential impacts to launching watercraft for emergency rescue operations. This will include analyzing inventory data and comparing it to water elevation data on the dates of the surveys. In addition, FirstLight has proposed to develop a hydraulic model of the Turners Falls Impoundment, bypass reach and of the Connecticut River below Cabot Station down to Holyoke Dam (Study 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot Station*), which will also be used in the assessment of impacts to recreational access from water level fluctuations. The Licensee is also proposing to complete *Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace* (Study 3.3.9), which will be reviewed as part of this assessment to determine whether direction of flow has an impact on recreational facilities and access.

Task 3: Report Development

FirstLight will prepare a report with the results of the study, including a determination if there are access issues due to fluctuating water levels and where they may be occurring.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the assessment as proposed above is sufficient to determine if the operation of the Projects has an effect on the recreation facilities or land use within the Project. It is estimated that this assessment will cost approximately $15,000-20,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was be held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

The *Assessment of Effects of Project Operations on Recreation and Land Use* will be initiated in the fall of 2014 but because the *Assessment* depends in part upon the results of other studies, the bulk of the assessment will be conducted in 2015. A progress report regarding the status of this study will be provided in 2014 in conjunction with the Initial Study Report.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.6.7 Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use

General Description of Proposed Study

A number of stakeholders requested this study including: NPS, AMC, VRC, FCRP, and Ms. Krug. This study is designed to determine the number of existing recreation facilities, the number and types of amenities available at each facility and the overall condition of the facilities associated with the Northfield Mountain Project. This will include a review of the trail system and climbing ledges located within the Northfield Mountain Project boundary.

NPS/AMC et al request that the study of the Northfield Project recreation facilities include a survey that seeks to determine what discourages the public from using the facilities. FirstLight proposes to use the contact and mail surveys conducted as part of the *Recreation Use/User Contact Survey* (Study No. 3.6.1) to seek out what improvements may be needed. As set forth, however, in the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boating* (Study No. 3.6.4), FirstLight does not propose to conduct a survey of non-users or displaced users because such a survey will not yield reliable or meaningful information in consideration of the level of effort required.

Ms. Krug requests that FirstLight evaluate trail networks in Franklin County to determine the need for additional trails and to conduct a site visit to some of these trails. This was not adopted because these trails are located outside of the Project area. FirstLight is proposing to gather information regarding the trail needs for mountain biking as part of the user contact survey proposed in *Recreation Use/User Contact Survey* (Study No. 3.6.1).

NPS requests that FirstLight evaluate its expenditures over the term of the current license in support of the facility, its promotion, and usage and extrapolate in current dollars, what would be necessary to bring the facility up to the quality and level of use that applicable FERC regulation prescribe. Past expenditure information is available on the FERC Form 80 and has not been included as part of this study. As part of its license application, FirstLight will provide estimates for any proposed recreational improvements.

Ms. Krug asks for online user surveys to talk to mountain bike groups regarding the needs of mountain bicyclists and assess interest in opportunities at Northfield Mountain. Internet surveys are not appropriate for quantitative analysis because they are not representative of the general recreational user population and do not provide reliable results. FirstLight proposes to use the results of the surveys proposed in the *Recreation Use/User Contact Survey (*Study No. 3.6.1) to seek out what improvements may be needed.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of this study are as follows:

- Determine whether the Northfield Mountain Tour and Trail Center has met recreation needs and if improvements or additions are necessary at the Center with a consideration of potential needs over the course of the 30 to 50 year new license; and
- Identify uses taking place on the current trail system and whether the current trail system is suitable and adequate for sustaining those uses, including evaluating the condition of existing trails e.g., erosion, drainage, width, slope, or obstacles.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreation opportunities associated with the operation of the Northfield Mountain Project.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

The Northfield Mountain Tour and Trail Center, Northfield Mountain Trail System and Northfield Mountain Mountaintop Observation Area provide numerous recreation opportunities within the Northfield Mountain Project boundary. Although they are not formal recreation facilities, Rose Ledge and Farley Ledge provide climbing opportunities to the public. The three formal recreation –facilities are described in detail below.

Northfield Mountain Tour and Trail Center: This site, which is also known as the Visitor Center, is located within the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in Northfield, MA. The Center is owned and managed by the Licensee and is available for day use activities. Available opportunities include viewing interpretive displays, picnicking, and educational programs. The Center has restrooms, cross-country ski rental equipment, and parking. It is open for year-round recreational and educational use.

Northfield Mountain Trail System: The trail system is located at the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in Northfield, MA. Over twenty-six miles of trail are available for hiking, biking, trail running, horseback riding, snowshoeing, and cross-country skiing. Climbers currently utilize a portion of the trail system to access Rose Ledge.

Northfield Mountain Mountaintop Observation Area: This site is located adjacent to the Northfield Mountain Project upper reservoir. The Observation Deck is owned and managed by the Licensee and is accessible by using the trail system.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of Project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Review of Existing Information

The Licensee proposes to use data collected as part of the *Recreation Use and User Contact Survey* (Study No. 3.6.1) to identify opinions of current recreation users of the Northfield Mountain recreation facilities and public education programs offered at the visitor's center. Prior to conducting field work associated with this study, a review of proposed trails, existing aerials and property ownership will be conducted.

Existing hiking and biking trail information for the Northfield Mountain area will be reviewed, as well as best management practices set forth by the International Mountain Bicycling Association, the USFS Trail Classifications, and the MA Department of Conservation & Recreation's Trail Guidelines and Best Practices standards.

Task 2: Field Work

The Licensee will conduct a field review of the current trail system, climbing sites, and the existing portion of the New England National Scenic Trail. This will include locating the sites with a GPS, if the information does not currently exist; photographing and recording the current amenities and conditions of the sites; and determining if there is a need for improvement. Trail characteristics at Northfield Mountain such as grade, cross slope, width, surface material/firmness, width, and drainage will be assessed and typical characteristics will be recorded.

Task 3: Desktop Analysis

A desktop analysis will be conducted to compare field data, survey data, and existing information. The analysis will determine if the current facilities are meeting the existing recreation needs at Northfield Mountain and provide a list of potential improvements that could be completed if the need arises over the course of the license.

Task 4: Report Development

The information collected will be compiled within a written report.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain information on recreational facilities and amenities at Northfield Mountain, within the Northfield Mountain Project boundary. The estimated cost for the study outlined in this plan is approximately $50,000-$55,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

The review of existing information will be conducted in January through May of 2014. The field work will be completed during all four season of 2014. The desktop analysis will be conducted November of 2014 through February of 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.7 Cultural Resources

3.7.1 Phase 1A Archaeological Survey

General Description of Proposed Study

In its PAD, FirstLight proposed to conduct a Phase 1A archaeological survey. FERC and the Town of Montague have requested assessments of archaeological resources. The purpose of the Phase IA archaeological survey is to identify known archaeological sites within the Turners Falls and Northfield Mountain Projects' APE that potentially may be eligible for inclusion in the National Register of Historic Places (NRHP) and to assess possible effects from the Projects' operations on those resources.

The area of investigation will include the FERC-defined APE as identified in the PAD, which includes the Projects' boundaries and any construction, recreational, or known locations effected by project operation outside of the Projects' boundaries. The Project APE is further defined by FERC as: "the lands enclosed by the Projects' boundary and lands or properties outside of the Project's boundaries where project construction and operation or project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist." The Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO will be consulted for concurrence with or refinement of this definition. Draft maps of the proposed APE are attached as Figures 3.7.1-1 – 3.7.1-5. A detailed map of the APE, which has the concurrence of the SHPOs and the Narragansett THPO, will be prepared and included in the Study Report. The proposed APE will also include the Fuller Farm property, located on Miller's Farm Road, just north of the Northfield Mountain Visitors' Center, which FirstLight is considering removing from the Project boundary as part of its relicensing proposal. See Figure 3.7.1-6.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to assist FERC in meeting its compliance requirements under Section 106 of the NHPA, as amended, by determining if licensing of the Project will have an adverse effect on historic properties.

The objective of the study is to identify known cultural resources listed in or eligible for listing in the NRHP and to identify and assess any potential adverse effects to historic properties from the continuing operation and maintenance of the Projects.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Section 106 of the National Historic Preservation Act (1966) requires that federal agencies, licensees, and those receiving federal assistance take into account the effects of proposed undertakings on any resource that is listed on or is eligible for the NRHP. As the lead agency, FERC is responsible for fulfilling the requirements of Section 106 in its decision to issue a new license to the Projects.

As stipulated by the regulations that implement Section 106 (36 CFR 800), the Massachusetts, Vermont, and New Hampshire SHPOs represent the interests of their respective States and their citizens, and advise and assist FERC in determining the significance of cultural resources within the APE. FirstLight proposes consulting closely with the SHPOs and the Narragansett THPO in the development of the survey methodology, identification of existing cultural resources and effects, establishment of its APE, and development of a Programmatic Agreement (PA) and HPMP, if needed.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Information contained in the PAD indicates that Native Americans have occupied the Connecticut River Valley as early as 14,000 years before the present day. Archaeological sites dating from the *Paleoindian* (before 8000 BC), *Archaic* (8000 BC – 1000 BC), and *Woodland* (1000 BC – AD 1600) periods, as well as the early Euro-American exploration, settlement, and industrial periods, may exist on lands bordering the Connecticut River. The Riverside Archaeological District in the Towns of Gill and Greenfield was listed in the NRHP in 1975 in recognition of significant archaeological remains known to exist in the Turners Falls vicinity. European settlement in the Connecticut River basin in what was to later become Northfield Township and the Town of Gill occurred as early as 1672. During King Phillip's War in 1676, Peskeopscut (Turners Falls) was the site of a military encounter between colonial forces under Captain William Turner and Native Americans. Following the American Revolution, transportation improvements included construction of the Upper Locks and Canal (1792-98) from Turners Falls to Montague. After the Civil War, Turners Falls developed as an important center of manufacturing with the establishment of the Turners Falls Company in the early 1870s. In the 1890s, Turners Falls continued to expand with construction of a new paper mill, shoe factory, and leather manufacturers.

To date, there have been no comprehensive, professional archaeological surveys of the Project APE to identify such resources. FirstLight therefore proposes to conduct the Phase IA archaeological survey to identify potential NRHP-eligible archaeological resources in the Projects' APE and provide information to assess potential adverse effects to such resources.

Project Nexus (18 CFR § 5.11(d)(4))

The proposed cultural resources study will provide information on known archaeological sites located within the Projects' APE. The resulting technical reports will provide information on which resources are potentially eligible for inclusion in the NRHP and what potential adverse effects to these historic properties would be created by the continued operation of the Project. Once the potential adverse effects are determined, the information that is developed during the course of the study may be used as the basis for preparing an HPMP. Guiding the Licensee's actions relating to Section 106 during the term of the new license, an HPMP would discuss how to avoid potential adverse effects or how they would be mitigated. A final HPMP would be filed with the license application.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1 – Meeting with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO

FirstLight will consult with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO to reach concurrence with respect to the precise APE for the Projects, the development of a sensitivity model, and archaeological field reconnaissance methodology. During FirstLight's June 14, 2013 Proposed Study Plan presentation, the Vermont SHPO indicated that a 10-meter-wide APE for archaeology along waterway shorelines has been utilized for hydroelectric relicensing projects in Vermont. FirstLight will attempt to obtain concurrence of this definition of the APE for archaeology prior to filing of the Revised Study Plan.

The Phase IA archaeological survey will conform to the professional standards and guidelines established by the SHPOS in each state. As indicated in the Massachusetts SHPO Proposed Study Plan review letter of April 24, 2013, and their review letter of June 21, 2013 of the Project Notification Form, all proposed archaeological investigations in the State of Massachusetts will be conducted under a State Archaeologist's Permit (950 CMR 70). FirstLight will also employ a professionally qualified archaeologist who meets the *Secretary of the Interior's Standards* and has previous relevant experience in the ancient and historic period archaeology of the Connecticut River Valley region to conduct the archaeological studies. Prior to execution of field studies, FirstLight will identify an adequate curatorial facility for records of the investigation and any recovered archaeological materials, with a preference for curation within Massachusetts for the Massachusetts study area.

Task 2 – Background Research

FirstLight proposes to examine archaeological site files, cultural resources reports, and archives located at the Massachusetts, Vermont, and New Hampshire SHPOs, and other local and regional repositories, such as the Great Falls Discovery Center in Turners Falls and the Pocumtuck Valley Memorial Association in Deerfield. The purpose of this work is to examine relevant sources that may contain historical and archaeological information on the two Project areas in order to develop ~~prehistoric~~Precontact and historic contexts and an archaeological sensitivity model. As part of this study, FirstLight will endeavor to obtain background information from local historians, researchers, and other persons knowledgeable of the cultural history of the two Project areas.

Task 3 – Development of a Sensitivity Model

FirstLight will develop a sensitivity model, based on its consultation with the SHPOs and the Narragansett THPO, and on its background research to identify areas within the APE that are likely to contain archaeological resources. The development of a sensitivity model will aid in identifying the probable locations of Precontact- and historic-period archaeological sites. Models of Precontact human occupation in the Northeast suggest that populations utilized a variety of environments and ecotones to procure food and other resources and show that some areas were more attractive than others to establish camps and villages. Environmental settings typically associated with Precontact-period occupation include major rivers or creek valleys, rockshelters, springheads, stream confluences, well-drained lands along secondary streams, and bedrock outcrops for lithic resource procurement. Other factors include elevation, slope gradient, aspect, stream order, distance from fresh water, landform, soil type, and soil drainage. During the historic period, settlements were often found along transportation routes, including waterways. The development of a sensitivity model would result in a tripartite division of the APE into areas of High, Moderate, and Low Sensitivity for archaeological resources. FirstLight will consult with the SHPOs and Narragansett THPO to obtain their concurrence with the sensitivity model.

In addition, the results of the *2013 Full River Reconnaissance Study* (Study No. 3.1.1), will be reviewed and assessed by the professionally qualified archaeologist, in connection with its background research and development of the sensitivity model, and management recommendations will be made in the Phase 1A report, as appropriate.

Task 4 – Field Reconnaissance

FirstLight also proposes to conduct archaeological field reconnaissance of the Turners Falls Project and Northfield Mountain Project areas to confirm the sensitivity models and eliminate areas from further study as warranted. The field reconnaissance will consist of visual examination of selected portions of the Project areas, focusing primarily on landforms that have the greatest potential to contain archaeological resources, and as well as confirming areas of disturbance, steep slope, and wetlands, which would have little potential to contain archaeological resources. A limited number of soil cores may be taken to confirm soil characteristics and/or ground disturbances; it is anticipated that no other ground disturbance will be required for this study. The field reconnaissance is anticipated to occur over a three-day period. ~~The methods to achieve the goals of this study will be conducted in consultation with the SHPOs~~

~~following their professional standards and guidelines. FirstLight will employ a professionally qualified archaeologist who meets the *Secretary of the Interior's Standards* to conduct the cultural resources study.~~

Task 5 – Report Development

FirstLight will develop a report that contains a record of its consultation with the SHPOs and the Narragansett THPO, a summary of background research, Precontact and historic-period contexts for the Project environs, a description of the sensitivity model, the methods and results of Phase 1A reconnaissance, maps of the APE, and recommendations to conduct, if necessary, a Phase IB archaeological survey depending on the results of the study and in consultation with the SHPOs and the Narragansett THPO.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

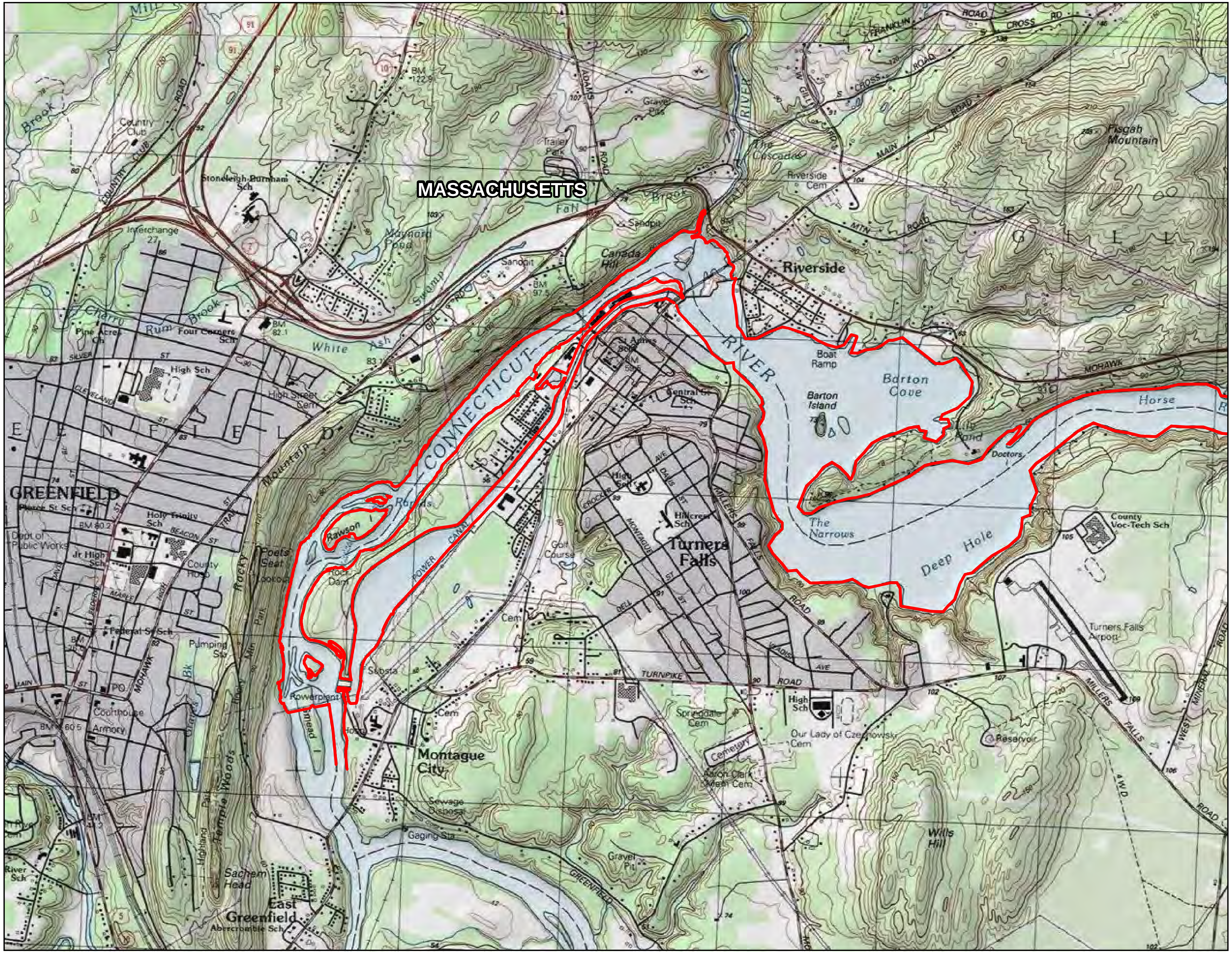
The estimated cost for the Phase IA cultural resources survey is between $60,000 and $70,000. FirstLight believes that the proposed level of effort is adequate to obtain needed information on Precontact and historic ~~and prehistoric~~ cultural resources within the Projects' APE and to determine the need for more intensive field surveys.

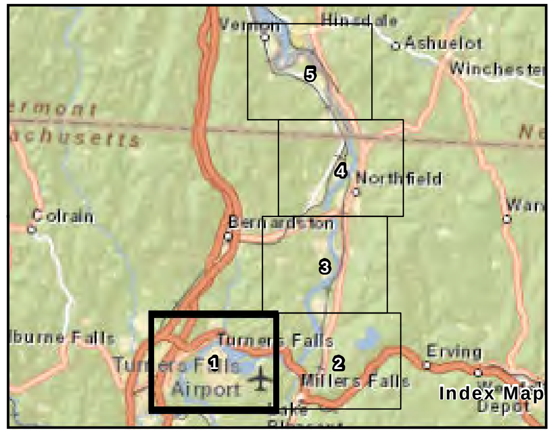
Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

Background research and development of a sensitivity model for the *Phase IA Archaeological Survey* will occur in winter-spring 2014. *Phase 1A* field reconnaissance will take place in summer 2014. Consultation with the SHPOs and the Narragansett THPO will take place throughout 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1





FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.1-1
Proposed Area of Potential Effect
(Archaeology)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

FirstLight Power Resources
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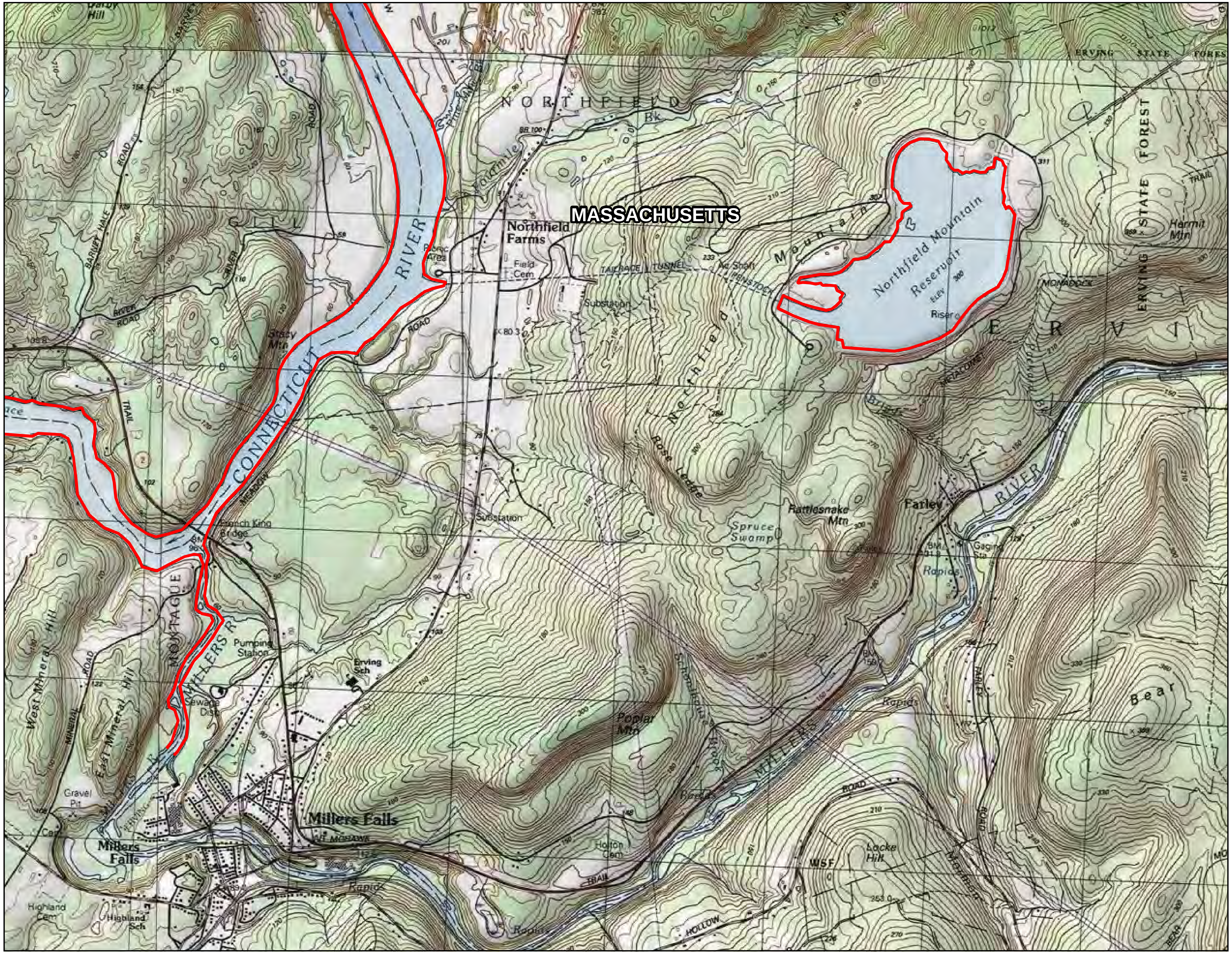

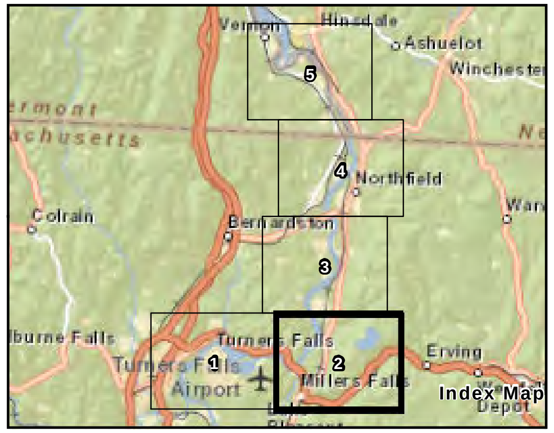

FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.1-2
Proposed Area of Potential Effect
(Archaeology)

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Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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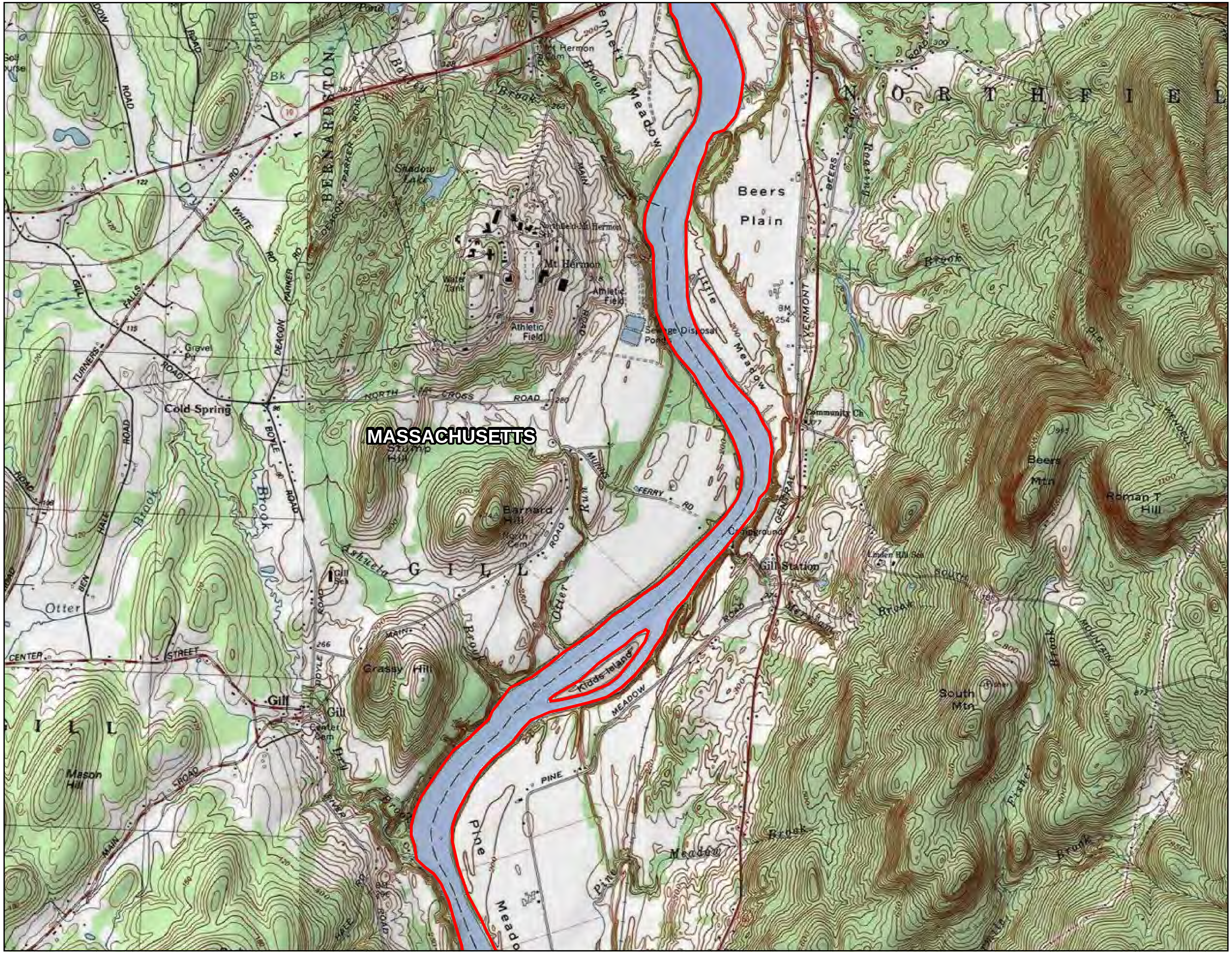

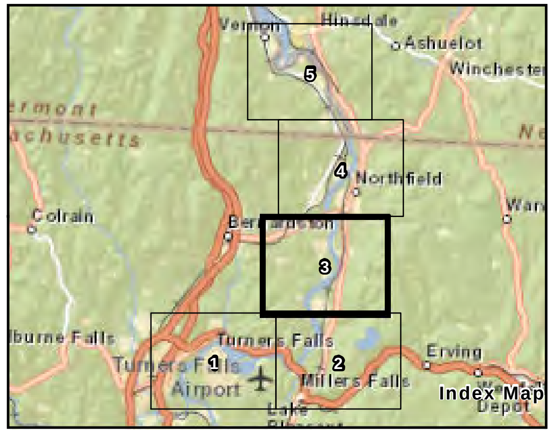

FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.1-3
Proposed Area of Potential Effect (Archaeology)

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Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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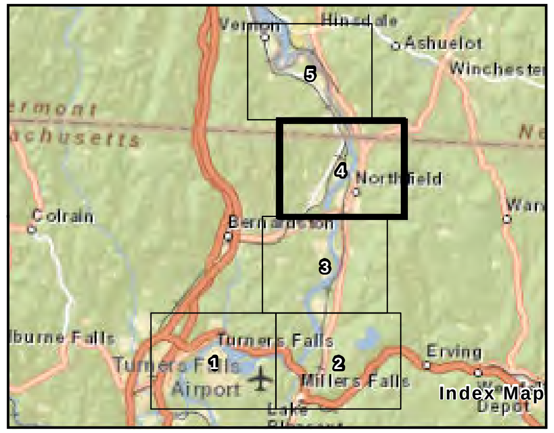

FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.1-4
Proposed Area of Potential Effect
(Archaeology)

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Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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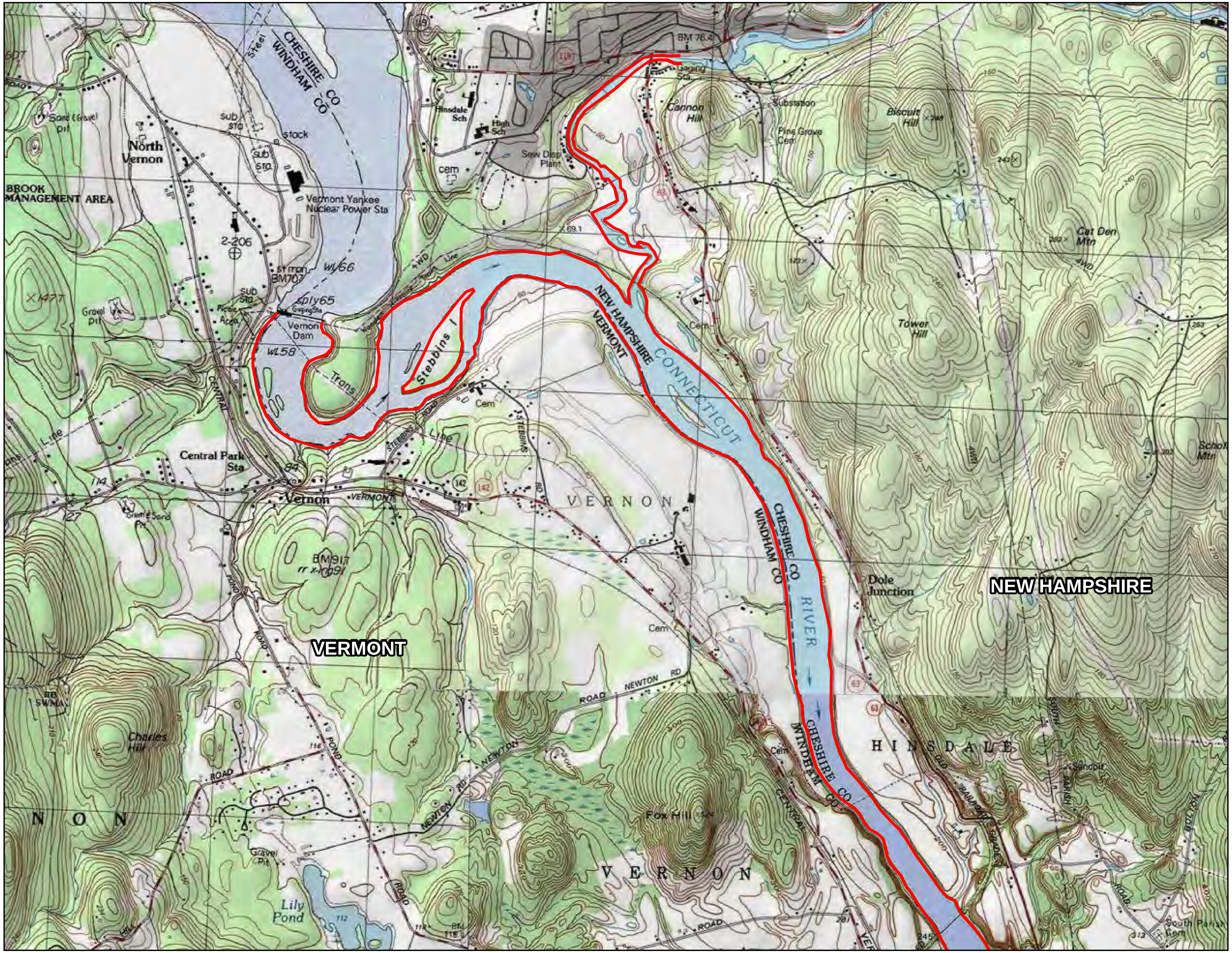

FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.1-5
Proposed Area of Potential Effect (Archaeology)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

FirstLight Power Resources
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FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.1-6
Fuller Farm Property Location

Legend

- Northfield/Turners Falls Project Boundary
- Farm Property
- Project Trail
- Agricultural Buffer
- Town Boundary
- NWI Wetland

Water Elevation

- Maximum
- Minimum

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Copyright:© 2012 Esri, DeLorme, NAVTEQ, TomTom
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

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1 inch = 300 feet

FirstLight Power Resources
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3.7.2 Reconnaissance-Level Historic Structures Survey

General Description of Proposed Study

In its PAD, FirstLight proposed to conduct a Historic Structures Survey. FERC also noted that FirstLight had proposed such a survey. The purpose of the reconnaissance-level historic structures survey is to identify historic resources within the Turners Falls and Northfield Mountain Projects' APE that are listed in or have been determined eligible for listing in the NRHP, to identify resources for further intensive survey and evaluation for NRHP-eligibility, and to assess possible effects from the Projects' operations on those NRHP-listed and –eligible resources. This will be accomplished through consultation with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO, site file research and literature review, and field studies. ~~A reconnaissance-level historic structures survey will be conducted to gather information on known historic architectural resources in the Projects' APE and to identify buildings, structures, objects, sites and districts for possible further intensive-level survey.~~ Existing information will be collected from records maintained at the Massachusetts, Vermont, and New Hampshire SHPOs, state and local libraries and historical societies, FirstLight's archives of architectural and engineering records, the Library of Congress, Historic American Building Survey/Historic American Engineering Record (HABS/HAER) and the National Register in Washington, DC.

The area of investigation will include the FERC-defined APE as identified in the PAD, which includes the Projects' boundaries and any construction, recreational, or known locations affected by project operation outside of the Projects' boundaries. The Project APE is further defined by FERC as: "the lands enclosed by the Projects' boundary and lands or properties outside of the Project's boundaries where project construction and operation or project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist." The Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO will be consulted for concurrence with or refinement of this definition. Draft maps of the APE are attached as Figures 3.7.2-1 to 3.7.2-5. A detailed map of the APE, which has the concurrence of the SHPOs and the Narragansett THPO, will be prepared and included in the Study Report. The proposed APE will also include the Fuller Farm property, located on Miller's Farm Road, just north of the Northfield Mountain Visitors' Center, which FirstLight is considering removing from the Project boundary as part of its relicensing proposal. See Figure 3.7.1-6.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to assist FERC in meeting its compliance requirements under Section 106 of the NHPA, as amended, by determining if licensing of the Project will have an adverse effect on historic properties.

The objective of the study is to identify cultural resources listed in or eligible for listing in the NRHP. If it is confirmed that historic properties are present, FirstLight with then move forward to identify and assess any potential adverse effects to historic properties from the continuing operation and maintenance of the Project.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Section 106 of the National Historic Preservation Act (1966) requires that federal agencies, licensees, and those receiving federal assistance take into account the effects of proposed undertakings on any resource that is listed on or is eligible for the NRHP. As the lead agency, FERC is responsible for fulfilling the requirements of Section 106 in its decision to issue a new license to the Projects.

As stipulated by the regulations that implement Section 106 (36 CFR 800), the Massachusetts, Vermont, and New Hampshire SHPOs represent the interests of their respective States and their citizens, and advise and assist FERC in determining the significance of cultural resources within the APE. FirstLight proposes consulting closely with the SHPOs and the Narragansett THPO in the establishment of the APE, development of the survey methodology, identification of NRHP-listed and –eligible historic resources, assessment of effects (if any) to the NRHP-listed and –eligible resources, and development of a PA and HPMP, if needed.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

European settlement in the Connecticut River basin in what was to later become Northfield Township and the Town of Gill occurred as early as 1672. During King Phillip's War in 1676, Peskeopscut (Turners Falls) was the site of a military encounter between colonial forces under Captain William Turner and Native Americans. Following the American Revolution, transportation improvements included construction of the Upper Locks and Canal (1792-98) from Turners Falls to Montague. After the Civil War, Turners Falls developed as an important center of manufacturing with the establishment of the Turners Falls Company in the early 1870s. In the 1890s, Turners Falls continued to expand with construction of a new paper mill, shoe factory, and leather manufacturers.

The Turners Falls Historic District, containing residential, commercial, and industrial buildings and structures associated with the nineteenth-century industrial history of Turners Falls, and including historic resources located within the Project boundaries, was listed in the National Register in 1982. Because there have been no comprehensive architectural surveys conducted within the Projects' APE, there is the potential for other NRHP-eligible resources located within the Projects' boundaries in Massachusetts, Vermont, and New Hampshire. These resources may include structures of historic, architectural, or engineering significance, as well as possible historic districts or historic rural landscapes. These resources will be identified during reconnaissance- and intensive –level architectural surveys proposed by FirstLight.

Project Nexus (18 CFR § 5.11(d)(4))

The proposed reconnaissance-level historic structures survey will provide information on known (previously identified and NRHP-listed) historic resources within the Projects' APE and will recommend resources for further intensive survey to establish eligibility for the NRHP. Following the reconnaissance-level survey in each state, FirstLight will consult with the appropriate SHPO and the Narragansett THPO to determine the need (if any) for further intensive survey to identify resources potentially eligible for NRHP listing. Once NRHP eligibility determinations have been obtained for the intensively surveyed resources, potential effects to these historic properties by continued Project operations will be assessed. Information developed during the course of the intensive survey will be used as the basis for preparing an HPMP. Guiding the Licensee's actions relating to Section 106 during the term of the new license, the HPMP will discuss how to avoid potential adverse effects and/or how they will be mitigated. The final HPMP will be filed with the license application.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1 – Meeting with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO

FirstLight will consult with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO to reach concurrence with respect to the precise APE for the Projects, the development of historic contexts, and field reconnaissance methodology. The proposed reconnaissance-and intensive-level architectural surveys will conform to the professional standards and guidelines established by the SHPOs in each state. FirstLight will also employ a professionally qualified architectural historian who meets the *Secretary of the Interior's Standards* to conduct the architectural studies.

Task 2 – Background Research

FirstLight proposes to examine architectural site files (not available on-line for previously surveyed resources in Vermont and New Hampshire and only partially online for surveyed resources in Massachusetts), cultural resources reports, National Register nominations and determinations of eligibility, historic maps and atlases, historic photographs and illustrations and building records located at the Massachusetts, Vermont, and New Hampshire SHPOs and other research repositories, such as the Great Falls Discovery Center in Turners Falls, the Pocumtuck Valley Memorial Association in Deerfield, local libraries and historical societies, and at FirstLight's offices. Background research may also identify resources that are less than 50 years old but that may be potentially NRHP-eligible under Criteria Consideration G.

Task 3 – Development of Historic Contexts

FirstLight will use the results of the background research to develop historic contexts to guide the field reconnaissance and will consult with the SHPOs and the Narragansett THPO regarding the required level of detail for the historic contexts.

Task 4 – Field Reconnaissance

FirstLight also proposes to conduct field reconnaissance ("windshield survey") of the Turners Falls Project and Northfield Mountain Project APE to identify architectural resources (buildings, structures, objects, and districts) 50 years or older. The windshield survey will be conducted by vehicle, foot, and/or by boat. Survey and reporting methods (including the use of digital and film camera photography) will follow the relevant Federal and SHPO professional standards and guidelines. FirstLight will employ professionally qualified architectural historians, who meet the *Secretary of the Interior's Standards*.

Task 5 – Report Development

FirstLight will develop a report that contains a record of its consultation with the SHPOs and the Narragansett THPO, a summary of the background research, a description of the historic contexts, results of the windshield survey, maps of the APE, maps showing the location of all NRHP-listed and previously identified resources, and recommendations to conduct an intensive-level architectural survey, depending on the results of the reconnaissance-level survey and after consultation with the SHPOs and the Narragansett THPO.

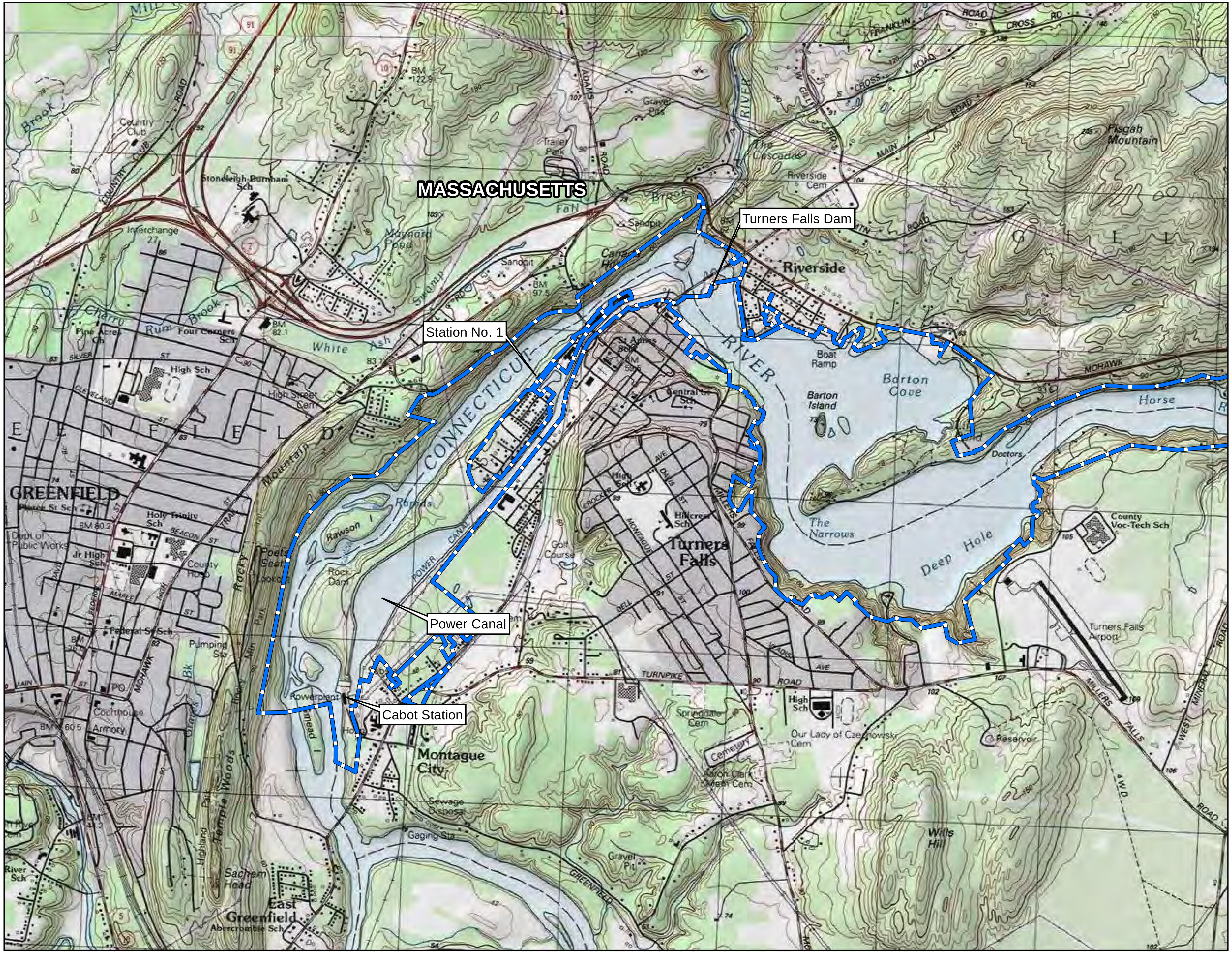
Level of Effort and Cost (18 CFR § 5.11(d)(6))

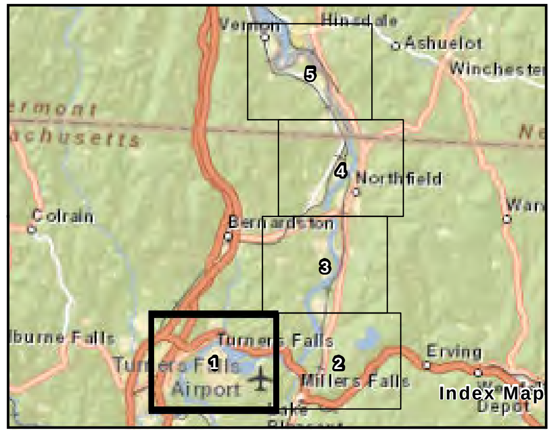
The estimated costs for the background research and windshield survey to identify 50-year-and-older resources within the Projects' APE are approximately $35,000 to $45,000. Costs associated with the intensive-level survey and assessment of effects will be developed following consultation with the SHPOs on the results of the reconnaissance-level survey. FirstLight believes that the proposed level of effort is adequate to obtain initial information on historic resources within the Projects' APE.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. The *Reconnaissance-Level Historic Structures Survey*, including both background research and field work will be conducted during the winter/spring of 2014, with SHPO and Narragansett THPO consultation continuing throughout 2014. The schedule for any intensive-level surveys and assessment of effects to NRHP-listed and –eligible historic resources will be determined following completion of the reconnaissance-level surveys.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.





FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.2-1
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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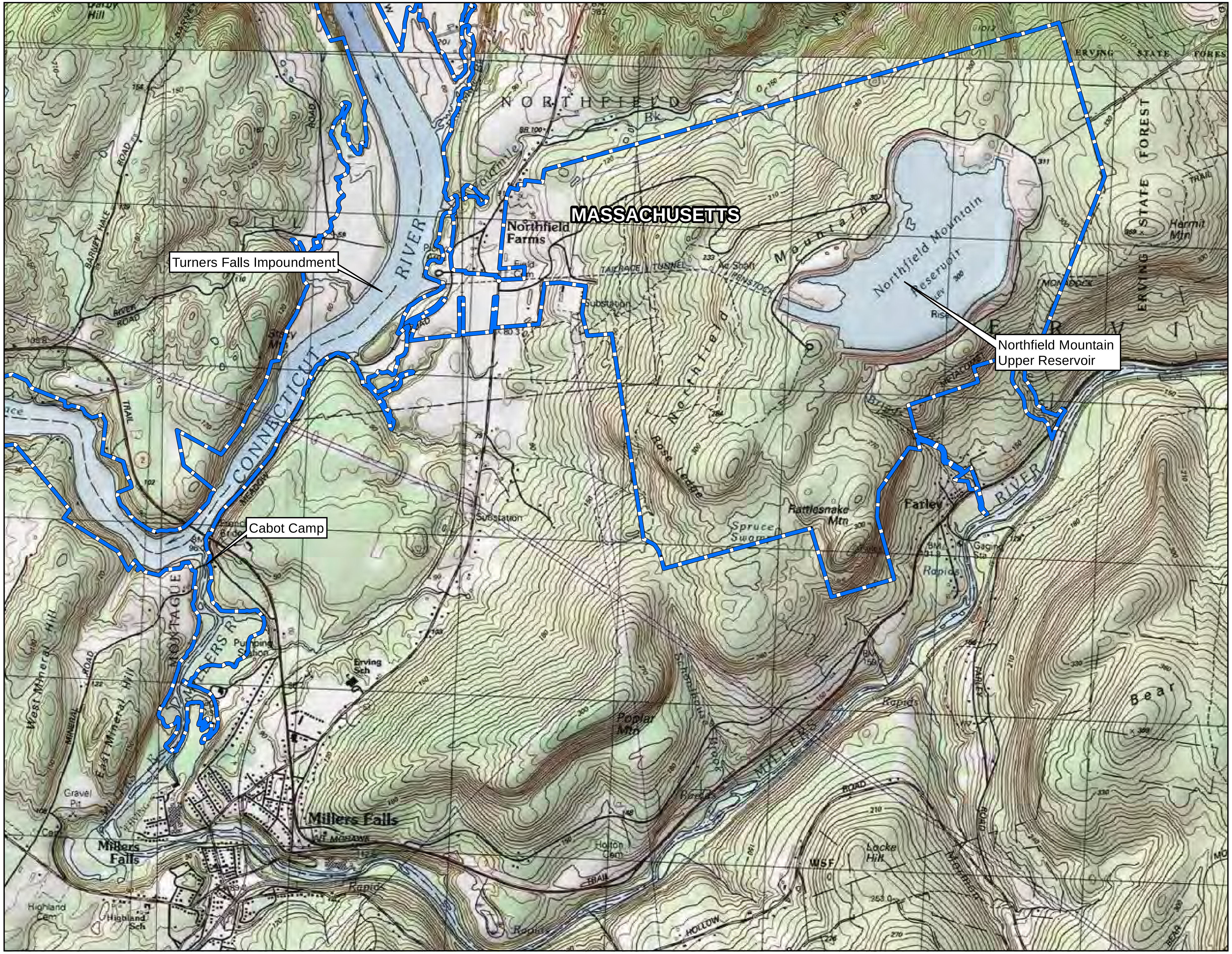

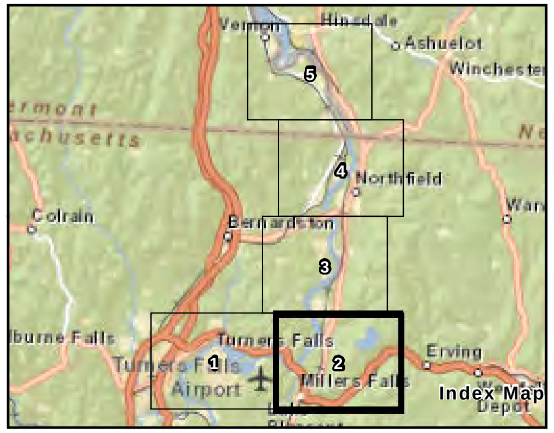

FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.2-2
Proposed Area of Potential Effect
(Historic Structures)

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Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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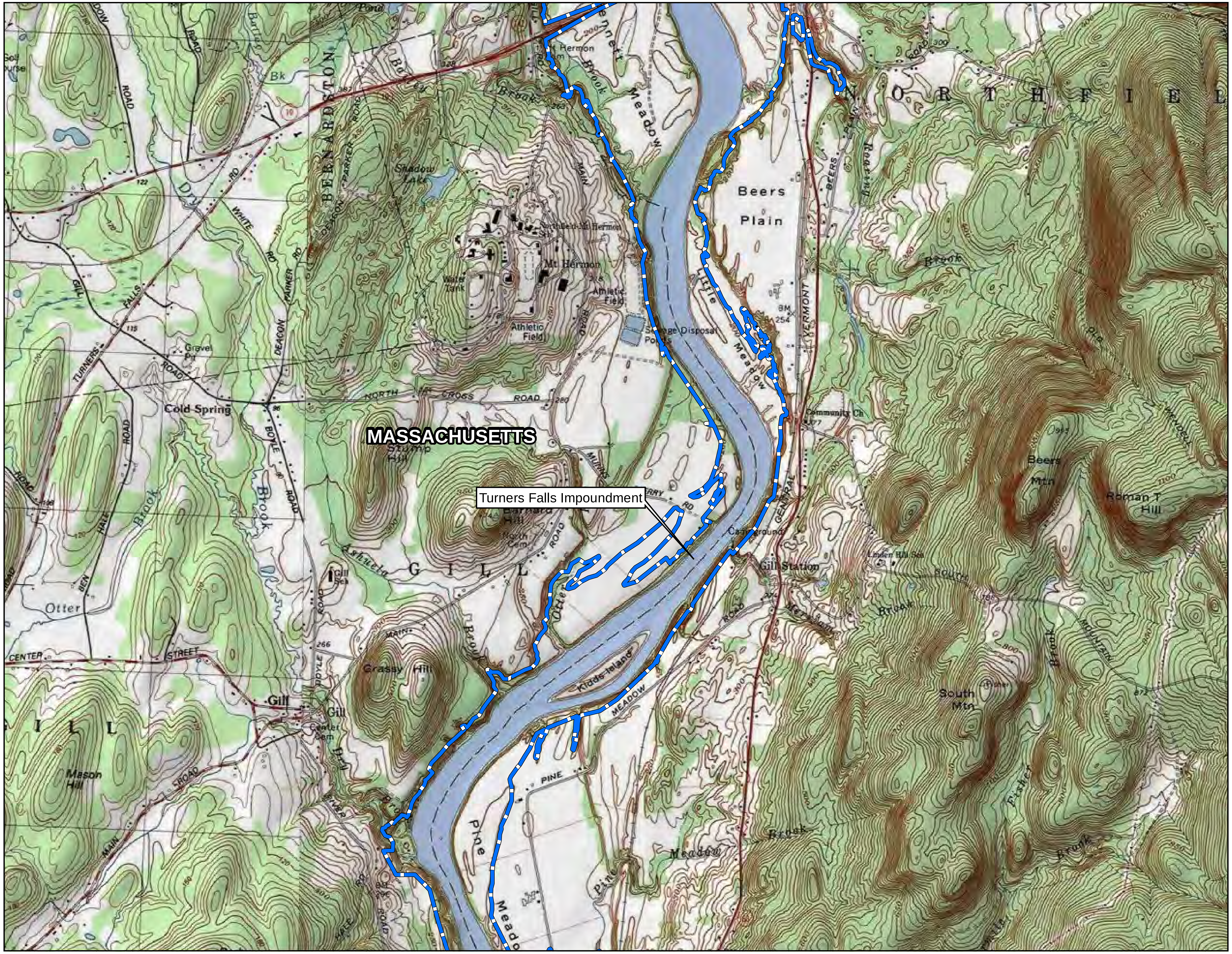

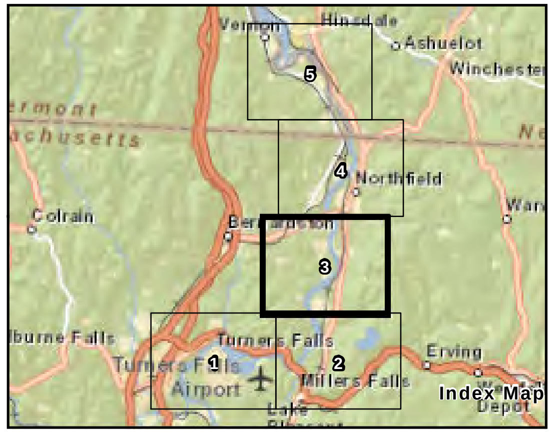

FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.2-3
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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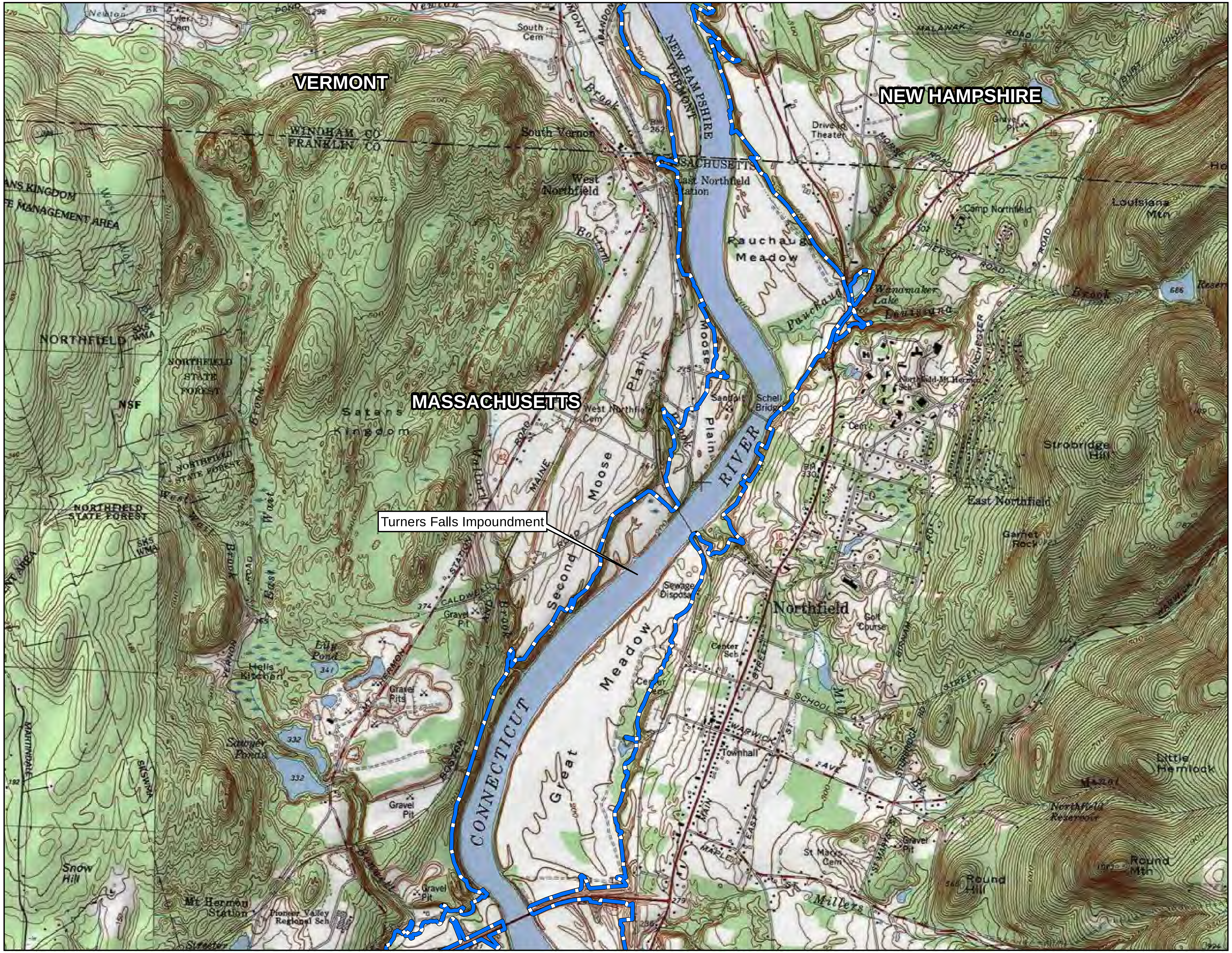
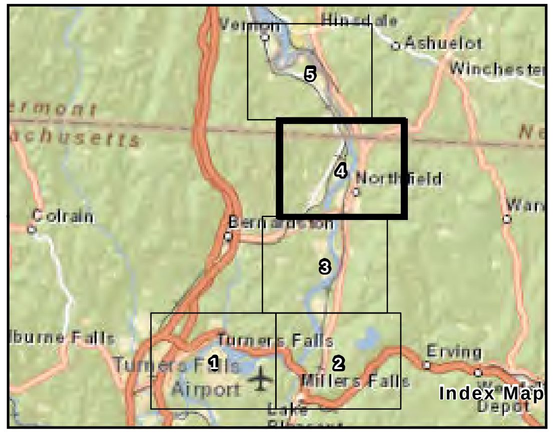
FirstLight Power Resources
GDF SUEZ





FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.2-4
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

N

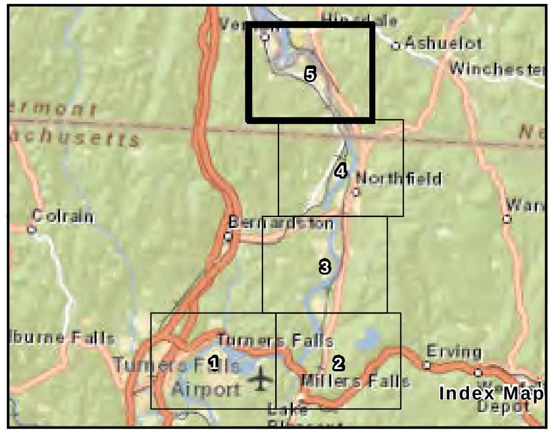
Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

0 1,000 2,000 4,000 Feet

1 inch = 2,000 feet

FirstLight Power Resources
GDF SUEZ

Path: W:\gis\maps\Study_Plans\archaeological_study\figure_3_7_2.mxd



FIRSTLIGHT POWER RESOURCES
UPDATED PROPOSED STUDY PLAN

Figure 3.7.2-5
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

FirstLight Power Resources
GDF SUEZ

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3.8 Developmental Resources

3.8.1 Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation

General Description of Proposed Study

A simulation model of the Connecticut River Basin will be used to evaluate the impacts of current and potential alternative modes of operation in the Project area on the timing and magnitude of river flows. Output from the model--- specifically flow data—will be used in other studies to evaluate the impact of current and potential alternative modes of operation on water surface elevations (hydraulic model) and aquatic habitat.

The Connecticut River Joint Commission (CRJC) requested a Connecticut River basin-wide stormwater model. The goals and objectives of the CRJC's study request refer to stormwater; however, the proposed methodology refers to a simulation model as described further below. FirstLight contacted the CRJC to clarify whether they are seeking a basinwide stormwater runoff model or a simulation; it appears they are seeking the latter (simulation model).

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals and objective of this study are to:

- To develop a baseline model of the Connecticut River Basin—specifically the reach from TransCanada's Wilder Project to the Holyoke Project-- which includes the following hydropower facilities: TransCanada's Wilder, Bellows Falls, and Vernon Hydroelectric Projects, FirstLight's, Turners Falls Hydroelectric Project and Northfield Mountain Project and Holyoke Gas and Electric's Holyoke Hydroelectric Project.

- The model will be used to determine the impact on hydropower generation and economics due to potential alternative modes of operation. Potential alternative modes of operation could include minimum flows in the bypass reach, changes in the Turners Falls Impoundment fluctuations, changes in operation of the Turners Falls Project relative to peaking operations, etc.

- Flow data generated from the model will be used to inform other studies, notably the hydraulic model and instream flow study.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

FirstLight proposed to develop an operations model of the Wilder, Bellows Falls, Vernon, Northfield Mountain, Turners Falls and the Holyoke hydropower facilities in the PAD.

The FRCOG Study Request No. 6 is entitled "*.Model River Flow and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Facilities*". FRCOG is requesting the development of a river model to evaluate the impact of Project operations on flows and water levels in the Project area.

The FRCOG Study Request No. 7 is entitled "*Develop a Comprehensive and Predictive Model of the Electric Generation System Consisting of Five Generation Projects along the Connecticut River to study the Impact and Feasibility of Various changes in Operations on Environmental Resources*. The FRCOG notes that the study objective is to determine whether operating the system (Wilder, Bellows Falls, Vernon, Northfield Mountain, and Turners Falls) as a whole under a single set of operation parameters could serve to mitigate the environmental impacts of current operations.

FirstLight believes that both of FRCOG's study requests can be addressed in the proposed simulation model of the Connecticut River Basin.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

The Nature Conservancy (TNC), USGS, USACE, and University of Massachusetts (UMass) at Amherst ("Project Partners") have developed a simulation and optimization model of the Connecticut River Basin. Software used for the simulation model is the USACE Hydrologic Engineering Center Reservoir Simulation model or HEC-ResSim. The optimization model was developed using software called LINGO. FirstLight has been working with Project Partners and provided them with engineering and operations data on the FirstLight facilities to enter into the HEC-ResSim model. Project Partners have provided FirstLight with the HEC-ResSim model of the Connecticut River Basin. HEC-ResSim is a simulation model and operates based on a set rules and constraints set by the modeler. The Connecticut River simulation model was developed on a daily time step for the period 1960 to 2003. More recently, The Nature Conservancy is considering extending the flow data to include 2004 to 2012. If the flow data is extended, FirstLight will include the additional years in their HEC-ResSim model.

Daily inflow for the model was developed by the USGS using its Connecticut River Unimpacted Streamflow Estimation (CRUISE) model. FirstLight is using the same daily inflow data, but will convert it to an hourly time step using straight line interpolation.

At the May 14, 2013 meeting, it was requested that more detail be provided on the flow data in the HEC-ResSim model. As noted above, the CRUISE model was used to develop unregulated inflows; however, the HEC-ResSim model would be used to simulate the regulated release from an Army Corps of Engineer Dam or hydropower facility (based on the rules in HEC-ResSim for that dam). For example, the regulated discharges from Vernon Dam (from the HEC-ResSim model) would be added to estimated flows from unregulated tributaries and/or overland sources located between Vernon Dam and Turners Falls Dams based on the CRUISE model, to result in a total inflow to Turners Falls Dam. Further details on the CRUSE model are included in a 15-page discussion paper "*Towards a publicly available, map-based regional software tool to estimate unregulated daily streamflow at ungauged rivers*". For copy of this paper, see the following weblink: http://static.rcngrants.org/sites/default/files/final_reports/RCN%202007-9%20GIS-based%20application%20manuscript.pdf.

In general, the CRUISE model relies on a regression analysis to estimate flow on ungauged rivers using USGS gaged unregulated rivers. As noted in the paper, daily streamflow is estimated by a four-part process as follows:

(1) Delineation of the drainage area and computation of the basin characteristics for the ungauged location,

(2) Selection of a donor stream gage,

(3) Estimation of the daily flow-duration curve at the ungagged location

(4) Use of the donor stream gage to transfer the flow duration curve to a time series of daily streamflow.

At the May 14 meeting, FERC asked if the license conditions for the 15-Mile Falls Project are reflected in the HEC-ResSim model. The HEC-ResSim model used for this relicensing effort reflects the current FERC licensed conditions of the 15-Mile Falls Project.

Project Nexus (18 CFR § 5.11(d)(4))

Potential changes in project operations at the three TransCanada Projects and FirstLight Projects will have a direct impact on the generation and economic viability at the Turners Falls Hydropower Project and the Northfield Mountain Project. Output from the model, most notably time varying flows, will be used in other studies (hydraulic model, instream flows study).

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

FirstLight proposes to conduct the following tasks using the HEC-ResSim simulation model.

Task 1. Modify Model

The Project Partner model provided to FirstLight is on a daily time step. FirstLight will modify the model such that daily unregulated flow data is converted to an hourly time using straight line interpolation. In the end, an hourly time step model will be developed for the period 1960 to 2003. As noted above, if The Nature Conservancy extends the flow record to include 2004-2012, FirstLight will likewise extend the HEC-ResSim model to include the same period. The model provided by Project Partners will be refined further to better simulate the timing of pumping and generating cycles at Northfield Mountain and the use of reservoir storage in the upper and lower reservoirs. Other modifications to the model will include: a) properly simulating the timing and magnitude of fish ladder flows, attraction flows, bypass flows, and b) properly simulating the use of upper and lower reservoir storage.

Task 2: Calibration

The model will be calibrated to flow and generation using observed data for a recent year such as 2002 or 2003[45]. If the model flow data is extended to include 2004-2012, FirstLight will revisit the calibration to include more recent years. Relative to flow, the model predicted daily (and hourly) hydrograph will be compared against the daily (and hourly) hourly hydrograph at the USGS Gage in Montague City, MA, located below Cabot Station. Comparing model predicted flow and observed flow at the gage will indicate if the model is reasonably matching the timing and magnitude of streamflow. In addition to flow, total monthly generation predicted by the model will be compared to the observed monthly generation at the three TransCanada Projects, Northfield Mountain Project and Turners Falls Project. It will be important to review the FirstLight log sheets to determine if there were any station or individual unit outages as the model will not account for outages. The model would over-predict generation if there is a prolonged outage. Based on flow and generation findings, some fine tuning of the HEC-ResSim model may be needed to match observed conditions.

Note that the year selected for calibration (2002 or 2003) may not represent the current project equipment. For example, say in 2007 the turbines at Cabot Station were upgraded meaning that the turbine efficiency would be improved over the turbines in place in 2002 or 2003. For calibration purposes, FirstLight will rely on the equipment installed during the years selected for calibration. Again, as noted above, if more updated flow data becomes available, FirstLight will revisit the calibration to include more recent years.

[45] The inflow data for the model provided to us by TNC terminated in 2003.

Task 3. Establish Baseline Model

Once the model is calibrated, it will be updated to reflect today's equipment and operating conditions and is termed the baseline model. Output from the baseline model including generation, flows and water levels will be used as a basis of comparison to any other model runs.

Task 4. Production Runs

A production run is considered any change made to the baseline model. The HEC-ResSim model allows for simulating alternative modes of operation based on a set of constraints and rules. Alternative modes of operation that can be simulated in the HEC-ResSim model include:

- Changes in the allowable water level fluctuation in a given reservoir;
- Changes in the magnitude and timing of bypass flows;
- Changing the magnitude and timing of fishway flows and attraction flows;
- Changes in the timing and magnitude of hydropower releases;
- Placing maximum discharge constraints on hydropower releases
- Changing the hydraulic capacity at a given facility.

If a stakeholder seeks an alternative mode of operation, such as maintaining bypass flows, the impact on generation, reservoir water levels and flows can be compared between this "Production Run" and the baseline model.

Task 5. Use of Model Output for other Uses

Output from the HEC-ResSim model will be used to inform other studies. For example, Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station* will include a habitat time series analysis. The hourly discharge hydrograph from the model at Montague City will be matched with the habitat versus flow relationship developed as part of the Study No. 3.3.1 to generate hourly varying habitat.

Task 6. Report

A report will be developed documenting the model inputs (engineering data, physical data, and flow data), and results from the calibration model, baseline model and Production Runs

Level of Effort and Cost (18 CFR § 5.11(d)(6))

Because FirstLight is using the HEC-ResSim model initially developed by the Project Partners, the level of effort is less than if developing the model from scratch. However, the model provided to FirstLight will still require significant updates to reflecting the intra-day operation and dispatch of the project, which cannot be simulated in a daily time-step model. Model calibration, establishment of a baseline model, development and simulation of Production Runs and a report are needed. The estimated cost of the modeling effort is on the order of $100,000 to $125,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Development of the simulation model does not require the collection of any field data. As such, FirstLight plans on completing model calibration and establishing a baseline model in 2013. Additional modeling of will be conducted in 2014 and 2015 as field studies are completed that will better inform potential Production Runs. For example after the instream flow study is complete, it will be used to inform potential bypass flows, which will be simulated in the model to evaluate impacts on generation.

4.0 STUDIES NOT INCLUDED IN THE PSP

The following section describes the studies not included in FirstLight's PSP.

4.1 Geology and Soils

4.1.1 Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage Operations

The following groups requested the same study: FRCOG, CRWC, FCD, Town of Gill, and LCCLC. In addition, NHDES and VANR requested a similar study titled *Vernon and Turners Falls Hydroelectric Projects: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations in New Hampshire.*

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

Proponents state that the study objectives would be to: (1) calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Project came on-line; (2) document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession; and (3) identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FRCOG, CRWC, FCD, Town of Gill, and LCCLC are not resource agencies.

Public Interest Considerations (18 CFR § 5.9(b)(3))

Proponents state that fish and wildlife are important public resources and as such it is in the public interest to maintain high quality habitat for migratory diadromous fish. Further, the proponents indicate that eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls Impoundment, the bypass reach, and downstream of Turners Falls Dam reduced the quality of habitat for these species.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents note several existing studies, including those contained in the PAD relative to Turners Falls Impoundment erosion, including past FRRs, Field Geology Services' 2007 fluvial geomorphic assessment of the Turners Falls Impoundment, and the 2012 investigations conducted by Simons and Associates. The proponents note that historic aerial photography of the Turners Falls Impoundment from 1929 aerials should be gathered and analyzed.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Proponents state that the construction of the Northfield Mountain Project was contingent upon the raising the Turners Falls Dam crest elevation by 5.9 feet which in turn has lead to water level fluctuations and increased boat activity. As a result, the proponents' state that erosion caused or contributed to the Northfield Mountain Project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon.

<u>Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))</u>

Proponents' methodology includes:

1. Determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss;

2. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. Create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel;

3. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided;

4. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks;

5. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlying the surfaces;

6. An analysis on the degree to which boat wakes increase that fluctuation range;

7. Determine erosion and riverbank failure process at identified sites;

8. Determine the effects of erosion on other resources; and

9. Develop a Shoreline Management Plan

<u>Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))</u>

Proponents' state: "*The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and some of the data collection could be done while other field studies are occurring*."

FirstLight's Rationale for Not Adopting the Proposed Studies

FirstLight does not see the need to conduct historical analysis of soil loss, erosion, nutrient loading, topography, or other geomorphic principles as requested for numerous reasons. First, as FirstLight has explained in many past FERC filings, rivers naturally migrate causing natural bank erosion, especially in the alluvial soils such as those flanking the Turners Falls Impoundment. Erosion could be caused by natural high flows, Project operations, boat wakes, upland management practices and other reasons. Thus, it is unclear why understanding the cubic yards of bank erosion in the impoundment is necessary. Second, in its *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria,* FERC reiterates that FERC uses current conditions as its baseline for evaluating project effects and alternatives and that this consists of the environment as it exists at the time of licensing.[46] FirstLight believes that the request is seeking a comparison to pre-raising-of-the-dam conditions. Finally, it is unclear how the requested data would inform potential PME measures. Additionally, FirstLight is not proposing to conduct topographic mapping or LiDAR along the 20-mile long Turners Falls Impoundment as existing topography is available from other sources and it is expensive. FirstLight will rely on the existing upland mapping obtained from USGS National Map Viewer- more specifically, the USGS 10 meter digital elevation model (DEM).

Relative to the long term monitoring transects as noted in a footnote in Field, 2007: *FirstLight has independently reviewed the 21 cross sections and checked the over 400 individual data sets and determined that a small percentage of them are suspect and should not be used for analysis. Therefore, it appears the problem is not extensive and it is unlikely the results of the analysis will change. FirstLight is working to resolve the matter.* For future monitoring, the cross sections will be monumented to allow for repeated measurements and they will extend into the floodplain.

FirstLight is proposing in Study No. 3.1.2 *Northfield Mountain/Turners Falls Project Operations Impact on Existing Erosion and Potential Bank Instability* to: (1) develop soils maps as a GIS overlay for use in field investigations, reducing the soil groupings to common types- likely ten, to more easily identify easily erodible soils as requested; (2) evaluate surficial mapping in locations where active or recent streambank erosion is occurring. Fixed recoverable cross-sections will be taken only in the areas of erosion; (3) analyze soils (classification, structure, parent material, etc.) at each transect; (4) conduct an analysis of water level fluctuations; and (5) analyze field collected data on boat (July 12-13, 1997 and July 26-27, 2008). In addition, some information on the number of boats will be obtained as part of the recreation studies; however, FirstLight is not proposing to collect the level of detail sought in the study request.

In regard to the NHDES and VANR request, components of the objectives described in Task 7 and 8 are captured in Study No. 3.1.1 *2013 Full River Reconnaissance Study* and Study No. 3.1.2 *Northfield Mountain/Turners Falls Project Operations Impact on Existing Erosion and Potential Bank Instability* therefore FirstLight is not proposing to collect the level of detail sought in the study request. FirstLight is not proposing to develop a Shoreline Management Plan as requested in Task 9.

[46] *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, at p. 14 (Federal Energy Regulatory Commission, Office of Energy Projects, March, 2012)

4.1.2 Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River.

The following groups requested the same study: FRCOG, CRWC, FCD, Town of Gill, LCCLC, and NHFGD.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

Proponents state that the study objectives would be to: (1) assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam; (2) identify management measures to minimize erosion and sedimentation; (3) determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels; and (4) identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FRCOG, CRWC, FCD, Town of Gill, and LCCLC are not resource agencies.

NHFGD state that in order to meet the objectives of the federal Clean Water Act, MADEP adopted the Massachusetts Surface Water Quality Standards, 314 CMR 4.00. Additionally NHFGD notes, MADEP has designated the Connecticut River as a Class B river for its entire length in Massachusetts, 314 CMR 4.06(5). Class B rivers are assigned the designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, 314 CMR 4.05(3)(b). Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses.

Public Interest Considerations (18 CFR § 5.9(b)(3))

Proponents state that Connecticut River is a valued public resource and that the public has a strong interest in protecting the water quality of the river to maintain its status as a Class B river, as designated by MADEP, 314 CMR 4.06(5).

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents note that the PAD provides a summary of the work that has been done to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. The entities also note the implementation of the *Sediment Management Plan* (revised February 15, 2012) and the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999).

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Proponents state that current water level fluctuations in the Turners Falls Impoundment, combined with proposed increased flow at the Northfield Mountain Project, have resulted/will result in the discharge of large quantities of sediment. Additionally, the proponents assert that sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Proponents' methodology includes:

1. Implementing the Northfield Mountain Pumped Storage Project *Sedimentation Management Plan* over the full range of river flows and pumping/generating cycles. Develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition;

2. Add one suspended sediment monitoring site downstream of the tailrace. If equipment continues to be problematic, explore other options. Provide data representative of tailrace discharge conditions and river conditions for two years;

3. Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions;

4. Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions;

5. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas, and channels;

6. Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove;

7. Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species;

8. Investigate the formation of beaches using remote sensing, LiDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS;

9. Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir;

10. Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users;

11. Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities;

12. Identify a prioritized list of locations for bank stabilization projects in the Project Area;

13. Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion;

14. Any historic information of existing bed substrate material in the Turners Falls impoundment, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming the historic data exist;

15. Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation; and

16. Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

Proponents' state: "*Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the Erosion Control Plan for the Turners Falls Pool of the Connecticut River (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and should accomplish many of the objectives listed above.*"

FirstLight's Rationale for Not Adopting the Proposed Studies

The majority of the tasks outlined in the Proponents' methodology are included in other studies found in the PSP, including:

- Study No. 3.1.1 *2013 Full River Reconnaissance Study* (Tasks 4, 12, 13);
- Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impacts on Existing Erosion and Potential Bank Instability* (Tasks 3, 4, 8);
- Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach, and below Cabot Station* (Tasks 3, 10, 16);
- Study No. 3.3.13 *Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat* (Tasks 7, 15);
- Study No. 3.3.14 *Aquatic Habitat Mapping of Turners Falls Impoundment* (Tasks 7, 15);
- Study No. 3.3.17 *Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat* (Tasks 7, 15);

- Study No. 3.4.1 *Baseline Study of Wildlife and Botanical Resources at Northfield Mountain Project Area, Turners Falls Impoundment, the Bypass Reach, and below Cabot Station* (Tasks 7, 15);
- Study No. 3.5.1 *Baseline Inventory of Wetland, Wildlife, and Botanical Resources in the Turners Falls Impoundment, Bypass Reach, and Below Cabot Station and Assessment of Operational Impacts* (Tasks 7, 15); and
- Study No. 3.6.6 *Assessment of Effects of Project Operations on Recreation and Land Use* (Task 6, 15)

Tasks 1, 2, and 9 of the Proponents' methodology are included in FirstLight's *Sediment Management Plan* (filed with FERC February 15, 2012). 2013 field activities are currently underway including continuous suspended sediment monitoring at the Route 10 Bridge, continuous suspended sediment monitoring of the intake and discharge lines at the Northfield Mountain Project, and suspended sediment data collection of the entire cross section of the river at the Route 10 Bridge over a range of flows during a one month period. At the end of the monitoring period (2015) FirstLight will propose measures to address the entrainment of sediment into the Project works during upper reservoir drawdown or dewatering activities.

FirstLight does not believe that it is necessary to install an additional suspended sediment monitoring device as requested in Task 2. Suspended sediment monitoring activities outlined in the *Sediment Management Plan* are more than adequate to provide the data requested above and have been approved by FERC, EPA and MADEP. Data collected at the Route 10 Bridge using the LISST-StreamSide, combined with the LISST-SL, will provide a detailed picture of suspended sediment in the mainstem Connecticut River. LISST-HYDRO devices located in the Northfield Mountain Plant are installed in-line to capture water withdrawn from the Northfield Mountain tailrace during pumping and transferred from the upper reservoir to the tailrace during generation. The combination of data collected at these locations will allow for a correlation to be made to determine what, if any, effects Northfield Mountain Project operations have on suspended sediment in the Connecticut River. In the *Sediment Management Plan* FirstLight proposes to continue sampling in 2013 and 2014, but may propose modifications to the sampling program based on sampling results.

FirstLight does not see the need to conduct historical comparisons of bathymetric data, or any geomorphic historical comparisons, for numerous reasons. First, as FirstLight has explained in many past FERC filings, rivers naturally migrate causing natural bank erosion, especially in the alluvial soils such as those flanking the Turners Falls Impoundment. Erosion could be caused by natural high flows, Project operations, boat wakes, upland management practices and other reasons. Therefore, sediment accumulation found throughout the Project area could be caused by several factors. Thus, it is unclear why understanding the historical changes in bathymetry, or other geomorphic processes, is required. Second, in its *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, FERC reiterates that FERC uses current conditions as its baseline for evaluating project effects and alternatives and that this consists of the environment as it exists at the time of licensing.[47] FirstLight believes that the request is seeking a comparison to pre-raising-of-the-dam conditions. Finally, it is unclear how the requested data would inform potential PME measures. Additionally, FirstLight is not proposing to conduct topographic mapping or LiDAR along the 20-mile long Turners Falls Impoundment as existing topography is available from other sources and it is expensive. FirstLight will rely on the

[47] *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, at p. 14 (Federal Energy Regulatory Commission, Office of Energy Projects, March, 2012)

existing upland mapping obtained from USGS National Map Viewer- more specifically, the USGS 10 meter digital elevation model (DEM).

FirstLight does not use the spillway gates or log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities as suggested in Task 10, therefore management strategies to minimize sediment release will not be evaluated.

In regard to Task 16, it is FirstLight's belief that due to a combination of factors including the bed substrate of the Bypass channel, flood flows, and other hydrologic/hydraulic considerations discussed in Study No. 3.2.2 that mitigation of sediment starved reaches below the Turners Falls Dam is not feasible. Stream power through the upper portion of the bypass reach where bedrock outcroppings are located during high flows is high enough to scour any sediment deposition that may occur.

4.2 Water Resources

4.2.1 Watershed Wide Stormwater Model

The CRJC requested a watershed-wide stormwater model of the entire Connecticut River Basin.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

CRJC lists the study's goals as (1) take a cumulative watershed approach to the management of surface water, a public trust resource; (2) determine the effect on public interests from projected future stormwater flows and the operation of the dams; and (3) recommend measures to manage stormwater flows through the operation of the dams to protect public interests. CRJC lists the study's objectives as (1) identify public interests in the watershed that have a nexus to dam operations; (2) develop an integrated, sharable, and scientifically-rigorous stormwater model for the entire watershed; (3) assess the cumulate effect of the dams on public interests, and (4) recommend license conditions to protect, preserve and enhance public interests.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

CRJC is not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

CRJC states that the public needs to know the effects the dams and their operations have on the natural and human environment, particularly in the future when CRJC believes precipitation is expected to be more extreme. CRJC also states that the public needs to know if and how the dams can be operated to benefit public interests in addition to hydropower. CRJC further states that the dams are the most significant factor in regulating stormwater flows in the Connecticut River.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

CRJC states that existing data on the location of resources of concern, while well intentioned, are too often incomplete or inaccurate. They state that since instream and riparian uses are closely tied to the frequency, depth and duration of the inundation by the river, stormwater information needs to be modeled and modernized, as precisely as possible, for accurate application.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

CRJC states that stormwater flows in the river effect nearly every resource under study, from providing whitewater recreational activities to sustaining floodplain biological communities. They state that the dams, in which they impound and then release the water, relies entirely on available stormwater.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

CRJC states that the proposed approach to analyzing water flows is the preferred methodology for forecasting, and evaluating environmental and economic outcomes based on various dam management scenarios. They state that this approach is being utilized in the Connecticut River Watershed Restoration Project that is being undertaken by TNC, USACE, UMass, and the USGS. CRJC states that this study is being performed to help determine how management of large mainstem and tributary dams and water systems can be modified for environmental benefits while maintaining beneficial human uses such as water supply, flood control and hydropower generation.

CRJC notes that use of LiDAR is the preferred methodology for preparing digital elevation models. They noted the use of LiDAR at various locations; however, further detail on the method(s) to evaluate stormwater flows is not provided.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

CRJC states that development of the proposed stormwater model using LiDAR data could cost $2,000,000 or more.

FirstLight's Rationale for Not Adopting the Proposed Studies

It is unclear from CRJC's study request if they are truly seeking a basin-wide stormwater runoff model as the proposed methodology does not provide enough detail. FirstLight believes that two other studies proposed herein will address the CRJC's study objectives and goals. Those studies, and how they would aid in addressing the CRJC's concerns, are listed below.

3.2.2 *Hydraulic Model of Turners Falls Impoundment, Bypass Reach and below Cabot Station*

FirstLight is proposing to develop two hydraulic models. A HEC-RAS hydraulic model of the Turners Falls Impoundment has already been developed. This model will predict the water surface profile of the Turners Falls Impoundment under a range of flows and starting downstream boundary conditions (in short, the water level at the Turners Falls Dam). This model was developed using bathymetric data collected in 2006. The second model will extend from Turners Falls Dam to the Holyoke Dam and will require use of the existing flood insurance study data for the communities along this reach of the river. The model will provide information on water surface elevations at different locations based for a range of flow conditions and project operations..

3.8.1 *Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation*

FirstLight is proposing to use an existing HEC-ResSim model of the Connecticut River basin that was originally developed by TNC, USACE, UMass and the USGS—the same model as cited by CRJC in their proposed methodology. This model will evaluate how current and alternative modes of operation can impact streamflow, water elevations and hydropower generation.

FERC's Study Request criteria require that the requester explain any nexus between project operations and effects on the resource to be studied, and how the study results would inform the development of license requirements 18 CFR § 5.9(b)(5). FERC's handbook "*A Guide To Understanding And Applying The Integrated Licensing Process Study Criteria*," issued March 2012, provides explanation on how FERC applies the study plan criteria in evaluating study requests. Per the guideline, relative to project nexus, it states the study request should clearly explain the connection between the project and its potential effect on the applicable resource. FirstLight does not see a nexus between the project and stormwater runoff, especially in the entire Connecticut River Basin. The only nexus between the project and the timing and magnitude of stormwater runoff the limited area of impervious surfaces associated with the project. CRJC's study request – a stormwater model of the entire Connecticut River Basin- has no nexus to the FirstLight hydropower facilities.

Also, per the guideline 18 CFR § 5.9(b)(6), under proposed methodology the requester is required to explain how any proposed study methodology is consistent with generally accepted practices in the scientific community. The guidance document further notes that the study methodology should be as detailed as possible. It was difficult for FirstLight to understand CRJC's proposed methods as it was detailed and intertwined operations modeling and stormwater modeling.

FirstLight believes that CRJC's request fails to meet FERC's nexus and methodology criteria. However, FirstLight believes that the combination of the hydraulic and operations models will address CRJC's concerns.

4.2.2 Climate Change and Continued Project Operations

The Town of Gill, LCCLC, MADFW, CRWC, NHDES, and the USFWS requested studies on climate change as it relates to continued operation of the projects.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

The Proponents share the same study objectives: (1) quantify thermal loading contributed by each impoundment at each of the hydroelectric projects on the mainstem Connecticut River upstream through Wilder; (2) predict increases in temperature of the impoundments in the next 30-50 years due to climate change; (3) model the effect of various project modifications on river temperature under current conditions and climate change predictions; (4) use climate change prediction models to determine if the projects mitigate for generally warmer air and water temperatures by producing low greenhouse gas-emitting energy; and (5) determine how climate change will impact management of high flow events and whether changes to the dam structures would mitigate any adverse impacts of the existing project flood management protocols.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

USFWS states that the proposed study would help it accomplish its general goals of: (1) ensuring that PME measures are commensurate with project effects in order to meet regional fish and wildlife objectives; and (2) conserve, protect, and enhance fish and wildlife habitat affected by the projects. With specific reference to climate change, USFWS states that its goals are to minimize: (1) current and potential negative effects of project operations; (2) deep headpond drawdowns associated with the loss of stanchion logs, which it anticipates will increase due to more frequent climate change induced high flow events; and (3) project-related thermal increases to Connecticut River water temperatures. USFWS and others have developed a National Fish, Wildlife and Plants Climate Adaptation Strategy (Adaptation Strategy) which includes, among other actions, reducing non-climate stressors in order to help fish and wildlife adapt to climate change.

MADFW's statement of resource management goals is identical to USFWS's statement. MADFW further states that the study will facilitate collection of information needed to conduct effects analyses and develop PME measures. The Massachusetts Executive Office of Energy and Environmental Affairs has published the Massachusetts Climate Change Adaptation Report which identifies various strategies to preserve, protect, and restore natural habitats and the hydrology of watersheds.

NHDES states that it is responsible for issuing water quality certifications in New Hampshire under the Clean Water Act and for establishing and administering surface water quality standards. Surface water quality standards include designated uses, which include aquatic life, fish consumption, drinking water, recreation, and wildlife. NHDES also establishes criteria to protect the designated uses and meet the anti-degradation requirement. NHDES states that its surface water criteria for Biological and Aquatic Community Integrity provide for surface waters to maintain a balanced, integrated, and adaptive community of organisms with species composition, diversity and functional organization comparable to similar natural habitats, and that climate change effects on flow and temperature may impact aquatic life and other uses.

Public Interest Considerations (18 CFR § 5.9(b)(3))

CRWC states that the public has a strong interest in protecting and enhancing the fish, wildlife, and plants that depend on the Connecticut River and associated wetlands, banks, and floodplain habitats, and that the study will enable the potential climate change induced effects on these resources and consider potential measures to minimize ecosystem degradation and enhance adaption to climate change.

LCCLC and Gill state that they support the USFWS's resource management goals.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents all include identical discussions of existing information. They state that the PADs for FirstLight's and TransCanada's projects contain no information relative to climate change and how climate change predictions may impact future operation of the projects, or how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

The proponents state that TransCanada's PAD includes data showing that water temperatures increase from the upstream end of the Wilder Project headpond to the Vernon Project tailrace, but do not link the data to climate change. They also state that TransCanada's project uses stanchion bays to relieve high water levels, but there is no information on how frequently the stanchions are removed or how climate change might affect the frequency and seasonality of removal, with potential impacts to resources in the project reservoirs.

The proponents provide data collected by the National Marine Fisheries Service that shows increasing air temperatures in the Northeast since 1900. They also provide analyses showing that mean water temperatures for the Vernon Dam impoundment increased between 1974 and 2010.

The proponents also reference the summary in the PAD of water quality data for the Turners Falls and Northfield Mountain Pumped Storage (NMPS) projects, and a 1991 study that showed a maximum temperature difference in the Turners Falls reach attributable to the NMPS project operation of 0.21 degrees Celsius.

Proponents' Explanation of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

The proponents state that the projects which dam the Connecticut River have created a series of long impoundments with slow water velocities that cause increased thermal loading and higher water surface temperatures than in free flowing sections of the river. They add that warmer surface waters may be discharged downstream and with a cumulative impact of elevated downstream temperatures. They add that climate change models of the Northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and increased incidence of short-term droughts. They indicate that effects include potential impacts to populations or loss of species not tolerant of warmer temperatures, citing potential impacts to American shad migration as an example. With regard to TransCanada's projects, the proponents state that deep drawdowns from removal of stanchions during high flow events could adversely affect reservoir resources, and that such drawdowns could occur more frequently in the future.

Proponents' Explanation of how Methodology is Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

The proponents state that the study would quantify the thermal loading contributed by each impoundment using data for bathymetry, storage capacity, hydrology, and project operations. The individual impoundment and cumulative surface water temperature predictions would be used to predict future warming based on climate change models.

The study would then consider different potential measures to mitigate the effects of project and climate-change based warming, such as converting projects to run-of-river, making deep-water releases, removing dams, conducting large-scale riparian revegetation, and possibly others.

The proposed study would also "input to climate change models the amount of [greenhouse gas emissions] that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures."

Climate change models would be used to predict whether the frequency and timing of high flow events is likely to change in the future. If the models predict that the frequency or timing of high-flow events necessitating the removal of stanchion bays will increase, then the proponents would have the Commission require the licensee to evaluate structural or operational alternatives to mitigate adverse impacts of existing flood management protocols.

Proponents' Description of Level of Effort and Cost, and Why Alternative Studies are Insufficient to Meet the Stated Information Needs (18 CFR § 5.9(b)(7))

USFWS does not include any information regarding level of effort and cost, or why alternative studies are insufficient to meet its stated information needs.

NHDES states that the cost of a thermal loading analysis would be low to moderate because bathymetry data for the Turners Falls Impoundment and Northfield Mountain upper reservoir already exist, and that the remaining work consists of loading data into an appropriate model and computing the estimated load, then comparing it to surface water data from climate change prediction models. It also states that the high flood protocol study should have a low to moderate cost because climate change models already exist. The comments of MDFW, CRWC, LCCLC and Town of Gill are identical to NHDES' comments.

FirstLight's Rationale for Not Adopting the Proposed Study

Although it is reasonable to conclude that the Connecticut River project impoundments affect water temperatures, and that regional air and water temperatures may be elevated in the future because of climate change, the proponents have failed to explain how their proposed study is consistent with accepted practice. While it is possible to estimate future water temperature conditions in the project impoundments with conventional hydrologic studies, monitoring techniques, and predictive models, the proponents have made no effort to explain how such water temperature data and predictions would be married with climate change models to accurately predict the combined effects of the projects and climate change on Connecticut River water temperatures over time. Indeed, they have not identified any climate change models that are sufficiently sensitive to accurately predict changes in the temperatures of individual rivers or the frequency or seasonal distribution of high flow events in the short-term, let alone for the 30-50 year period of a new license. In fact, they identify no specific models at all. The literature citations to the USFWS comments merely cite generally a 2009 report on global climate change impacts in the United States which includes a three page summary of potential impacts to the Northeast and the (now final) Adaptation Strategy. The proponents have also made no effort to show why conventional hydrologic studies, monitoring requirements, and reopener provisions that have been employed in hundreds of other hydroelectric license proceedings are not adequate to address potential impacts of climate change that, to the extent they occur, are likely to develop in an incremental manner over many years. In sum, the study proponents have asserted, but in no way shown, that their requested study is consistent with accepted practice.

The proponents' failure to articulate a detailed, credible study proposal for linking regional climate change to water temperature effects from the Connecticut River hydroelectric projects, individually or cumulatively, is not surprising. A July 2012 report by the Columbia Law School Center for Climate Change Law, *Consideration of Climate Change in Federal EISs, 1009-2011*, reviewed a database of 227 federal agency EISs that substantively address climate change related impacts. The report finds:

> While greenhouse gas emissions from projects are frequently addressed in EISs, the effects of climate change on the proposed projects are considered far less often. *Preparing agencies face considerable scientific uncertainty about the severity and exact nature of climate change impacts at the regional level, and projections are even more difficult at the local level.* EISs of briefly analyze the impacts of climate change on the region or locality in which the project is located without addressing the direct impacts of climate change on the project itself. (p. 8) (emphasis added)

With specific regard to USFWS EISs, the study found:

> USFWS EISs address the impacts of climate change on a project primarily as they relate to specific plant and animal species. EISs address the effects of climate change on the habitat, food resources and behavior of individual species, especially those federally listed as endangered or threatened. *Analysis of the impact of climate change on a project is often limited to a brief discussion of climate impacts on wildlife species or vegetation as a secondary or compounding impact*. These species are discussed primarily in terms of their vulnerability to non-climate related impacts from the project (such as habitat loss or noise), and climate change is mentioned as an additional factor that might increase the cumulative impact on the species. (footnote omitted) (p. 11) (emphasis added)

The Commission has recognized the inadequacy of current day computer modeling to develop information useful for development of specific license requirements in several recent cases. *See, e.g.*, Study Plan Determinations for the Susitna-Watana Project No. 14241 (Feb. 1, 2013) at B-8 (rejecting agency requests for comprehensive study of climate change impacts on all resources in the river basin potentially affected by the proposed projects because the results would be too uncertain to rely upon for development of license conditions, the study would be very costly, and existing hydrologic studies and monitoring techniques are sufficient to develop license conditions); Lake Powell Pipeline Project No. 12966 (Jan. 21, 2009) Appendix A at 1 at 14-16) (for proposed water supply project with hydroelectric component, accepting applicant's proposal to use literature review and existing US Bureau of Reclamation regional climate change model to estimate potential effects of climate change on Colorado River flows, but finding an absence of climate change models sufficiently finely tuned to make reservoir operation decisions); and Toledo Bend Project No. 2305 (August 6, 2009) Appendix A at 16-17 (finding no evidence of climate change assessment with the accuracy to predict specific resource impacts that could serve as the basis for developing license conditions; and determining that conventional hydrologic studies and monitoring techniques are adequate for the purpose).

In sum, the proponents have not provided any reason for the Commission to require FirstLight to develop a highly problematic study that it is unlikely to produce any information that would be useful for the development of license conditions, particularly when existing methods and approaches are sufficient to develop information that will enable the Commission, licensee, and resource agencies to develop timely, appropriate responses to climate change impacts.

4.3 Fish and Aquatic Resources

4.3.1 Shad Population Model for the Connecticut River

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

In their study request letters, USFWS, NHFG, MDFW, NHDES, CRWC, and TU request that FirstLight develop an American shad population model utilizing existing data to quantify how project operations and potential restoration/mitigation measures impact the Connecticut River shad population.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

Requesting agencies and TU identified Resource Management Goals for this study as defined by the *Management Plan for American Shad in the Connecticut River Basin* (1992). Specific management objectives in the plan include the following: achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually; achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem; and maximize outmigrant survival for juvenile and spent adult shad.

In addition, requests identify a number of broader resource PME goals under the overall relicensing process.

Public Interest Considerations (18 CFR § 5.9(b)(3))

USFWS is a federal resource agency. NHFG, MDFW and NHDES are state resource agencies. CRWC and TU are not public agencies.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

As described in the PAD, the annual number of adult shad passing into the impoundment below Turners Falls rose, with substantial year-to-year variation, until 1992 when numbers began to decline. This decline was not predicted by the predictive abundance model developed by Connecticut Department of Energy and Environmental Protection (CTDEEP). The decline has been noted in other Atlantic coast shad populations as well. Several factors may contribute to the recent decline in the Connecticut River American shad population. Factors include: 1) increased predation mortality, especially by striped bass (Savoy & Crecco, 2004); 2) competition by gizzard shad (Gephard & McMenemy, 2004); and/or 3) reduction of repeat spawners (Leggett et al., 2004). In 2012 the largest number of American shad were lifted at Holyoke Dam since 1992. While reports indicate that the American shad run on the St. John's River in 2012 was also higher than recent years, not all Atlantic coast river experienced similar increases.

Appendix G of the PAD identifies over 30 upstream and downstream fish passage studies that have been conducted at the Turners Falls Project going as far back as 1969 to as recently as 2010. FirstLight has worked diligently with agencies to evaluate effectiveness of fish passage facilities at the Turners Falls Project, including identification of potential improvements that FirstLight anticipates will be evaluated under the relicensing process, such as designs developed for a fish lift to replace the existing Cabot Fishway that were developed in consultation with representatives of CRASC.

Starting in 2008, biologists from the CAFRC have evaluated shad passage through the new Gatehouse Fishway entrance that was constructed in 2007. Results of these evaluations and review of shad counts conducted by FirstLight have demonstrated that shad successfully pass through the new entrance flume, and have also led to iterative modifications since operation of the new entrance was initiated. These improvements have included the installation of flow controls within the fishway entrance gallery, modification of canal operating protocols, relocation of water level sensors, and installation of a temporary rock ramp from the bottom of the canal to the original entrance (the ramp is no longer in place).

Currently, shad appear to pass readily through the new entrance, but not through the original entrance. Flow control changes intended to ensure adequate flow through the new entrance and to the Spillway Fishway have resulted in excessive velocity and turbulence at the original entrance that may be inhibiting shad passage. FirstLight continues to work with CAFRC and agencies to assess alternative to improve passage at the original entrance.

Historic upstream passage telemetry studies have shown that the Northfield tailrace had no clear effect on shad movement through the impoundment. Some shad turned back upon reaching the Northfield tailrace both during operational and non-operational periods. More recently, the USFWS Connecticut River Coordinator and CAFRC have released radiotagged shad at various points in the river and tracked their movements from the release point to Vernon Dam. Results from that study will be available once data analysis has been completed.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Low upstream passage efficiencies and delays restrict river access to returning shad and can affect the ability of American shad to reach upstream spawning grounds while the ability to effectively pass downstream may affect outmigration and potential for repeat spawning.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access, and should be adaptable to allow the input of new data and other inputs. Proponents' listed a variety of model inputs.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

The Proponents' state: *"Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development."*

FirstLight's Rationale for Not Adopting the Proposed Studies

FirstLight is proposing a suite of upstream and downstream fish passage studies, an instream flow study in the Turners Falls bypass reach and downstream of the Turners Falls and Northfield Mountain Projects, and a desktop entrainment analysis for the Projects. Results of these studies, coupled with the vast number of previous American shad passage studies at the project facilities should be more than sufficient to assess fish passage needs and potential modifications to existing facilities necessary to achieve improved fish passage efficiency. Further, a predictive abundance model already exists which, while historically generating relatively accurate results, did not predict the downturn in returning shad numbers that likely result from difficult to predict variables such as competition and predation of other species. The study requests also include the ability for the model to analyze sensitivity of fish passage efficiencies at all Connecticut River Projects. While there may be a cumulative effect on the overall American shad population in the river, efficiency at a given upstream or downstream hydroelectric facility is independent of FirstLight's fish passage facility efficiencies.

It is unclear to FirstLight how output from the requested population model will contribute to FERC's analysis of project effects and potential PME measures as compared to results of existing and proposed fish passage effectiveness testing.

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4.4 Aesthetic Study

4.4.1 Noise Level Determination for Northfield Mountain Project Operations

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

The Proponent states that the goal of the study is to evaluate the current level of noise produced by the Northfield Mountain Project as heard by neighbors to the project, to determine if the proposed changes to the project increase the noise level, and to mitigate any present and future noise.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

This request was made by a private citizen, not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

The Proponent states that it is in the public's interest that this project and its expansion not negatively impact the quality of life for Northfield Mountain Project's neighbors. Noise negatively impacts quality of life.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

The Proponent does not identify any existing information pertaining to noise levels at the Northfield Mountain Project.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

The Proponent states that: *"Northfield Pump Storage Project runs pumps to move water to a holding reservoir, and turbines to harvest energy from the water. Both these operations involve large equipment that makes a lot of noise. This noise may be broadband, low frequency, or infrasonic pressure or vibration. Increasing the pump and/or turbine operation in frequency, size, or number could impact the amount of noise this equipment makes, so that it is more audible to neighbors. Noise might need to be mitigated e.g. via insulation, or prescribed combinations of equipment running, etc. to reduce noise impact on neighbors."*

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Additionally the Proponent proposes a 2-part process:

- Part A (1 year): neighbors to the project record unexplained noises including what type of noise and when, compare these lists with operating records of the Northfield Mountain Project to see if correlation exists
- Part B (1 year): If correlation exists, further study would be needed using MADEP protocols. This could be done simultaneously with Part A to increase turn-around time, or left until afterwards on the change it would not be needed. It could also be the first step in the process if Part A was not considered necessary.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

The Proponent states that the cost of determining a baseline noise level and comparing any old/new noises with operating records is relatively low. The Proponent also states, if it is determined that the Northfield Mountain Project is making noise then the cost of measuring the noise level would possibly be in the tens of thousands of dollars. Finally, the Proponent states that mitigating the noise would likely cost several hundred thousand dollars.

FirstLight's Rationale for Not Adopting the Proposed Studies

Due to the location of plant infrastructure deep inside of a mountain, FirstLight does not believe noise levels related to Project operations are at a level outside of the plant that could negatively impact the quality of life of Project neighbors. FirstLight believes the mountain, which the plant is located inside of, acts as a natural insulator of noise. This belief has been confirmed by FirstLight personnel who work outside of the mountain and have not heard excessive noise levels during Project operations. Moreover, contemporaneously with the filing of this Proposed Study Plan, FirstLight is filing in the project docket supplemental information which it believes shows there is no connection between the very localized noise associated with operation of the turbines and the noises heard by the requesters. In addition, no other allegations of noise disturbance have previously been made since the plant went into service in 1972. Finally, ~~In addition, due to the unique configuration of the plant inside of a mountain,~~ even in the event noise levels were found to be audible ~~at a level effecting~~ to Project neighbors, PME measures would a) not be possible, or b) be far too expensive to be feasible.

4.5 Recreation and Land Use

4.5.1 Contingent Valuation Study

New England Flow, American Whitewater, and The Appalachian Mountain Club (collectively referred to as FLOW) have requested that FirstLight conduct a contingent valuation study of providing paddling flows (e.g., for kayaking, canoeing, whitewater rafting, instructional paddling, and paddle-boarding) in the Turners Falls Project bypass reach.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

FLOW states that the goal of the requested study is to examine the regional economic benefits of various flow release alternatives in the Turners Falls Project bypass reach.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FLOW is not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

FLOW states that the public interest is economic stimulus.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

FLOW states that it is unaware of any existing information regarding the economic potential of the Turners Falls Project bypass reach for paddling flows. It does, however, cite to a study of the economic impacts of whitewater boating on a river in Vermont.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

FLOW states that understanding the economic values that could be provided by flow releases in the Turners Falls bypass for paddling recreation will assist FERC and other stakeholders in balancing the trade-offs associated with lost generation.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

FLOW states that the only methodology that will assess the economic value of paddling flows in the Turners Falls bypass reach is through a contingent valuation study that measures an individual's willingness to pay. FLOW also states that contingent valuation studies provide reliable, comparable information that can be used to frame license requirements.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

FLOW states that data should be collected through surveys and interviews of known paddling clubs, customers of commercial whitewater outfitters, outfitters of tubing equipment and kayakers, canoeists, and rafters of varying abilities. FLOW fails to describe the level of effort or cost that such data collection would entail or the level of effort and cost that other elements of a contingent valuation study would entail.

FirstLight's Rationale for Not Adopting the Proposed Studies

FirstLight disagrees that there is a nexus to Project operation and effects. Contingent valuation studies do not produce a reliable assessment of the potential economic impact of adding recreational opportunity to an area. Further, FERC has consistently found that monetization of non-power resources is inadequate in the context of assessing non-power values under Sections 4(e) and 10(a)(1). The Commission has stated that "for non-power resources such as aquatic habitat, fish and wildlife, recreation, and cultural and aesthetic values, to name a few, the public interest cannot be evaluated adequately only by dollars and cents."[48] In a recent Study Plan Determination, FERC did not adopt a request for a proposed economic study of non-power resources. FERC stated that "[n]othing in the [Federal Power Act] requires the Commission to place a dollar value on non-power resources. Nor does the fact that because the Commission assigns dollar figures to the licensee's economic costs require that the Commission do the same for non-power resources."[49]

FirstLight is proposing to conduct several studies related to recreational use and demand at the Turners Falls Project, including a controlled whitewater flow evaluation in the Turners Falls Project bypass reach, an assessment of access needs for paddling in the Project vicinity, and assessments of use and demand. These studies along with studies regarding other assessments of power and non-power resources at the Turners Falls Project bypass reach will provide FERC with the information it needs to craft a new license for the Project that gives equal consideration to power and non-power values and is in the public interest.

FirstLight also disagrees with FLOW's assertion that the only methodology that will assess the economic value of paddling flows in the bypass reach is through a contingent valuation study. Contingent valuation studies are not generally accepted within the scientific community. It is well settled that contingent value surveys are expensive, subject to bias,[50] and even "[s]tudies conducted in controlled experimental settings suggest that . . . contingent valuation . . . methods may overestimate values[51] producing "implausible" results[52] that fail by trying to reduce FERC's public interest test to a mere mathematical exercise."

Finally, FERC's Study Request criteria require that the requester describe considerations of level of effort and cost. 18 CFR § 5.9(b)(7). FERC's handbook *"A Guide To Understanding And Applying The Integrated Licensing Process Study Criteria*," issued March 2012, provides explanation on how FERC applies the study plan criteria in evaluating study requests. With respect to the level of effort and cost

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[48] *See e.g., Great Northern Paper, Inc.*, 85 FERC ¶ 61,316 (1998), *reconsideration denied*, 86 FERC ¶ 61,184 (1999*), aff'd*, *Conservation Law Foundation v. FERC*, 216 F.3d 41 (D.C. Cir. 2000) (nothing in the FPA requires the Commission to place a dollar value on nonpower benefits; nor does the fact that the Commission assigned dollar figures to the licensee's economic costs require it to do the same for nonpower benefits.); *City of Tacoma*, 84 FERC ¶ 61,107 (1998), *order on reh'g*, 86 FERC ¶ 61,311 (1999), *City of Tacoma v. FERC*, 460 F.3d 53 (D.C. Cir. 2006).. *See also*, *Namekegon Hydro Co.*, 12 FPC 203, 206 (1953), *aff'd*, *Namekegon Hydro Co. v. FPC*, 216 F.2d 509 (7th Cir. 1954) (when unique recreational or other environmental values are present such as here, the public interest cannot be evaluated adequately only by dollars and cents); and *Eugene Water & Electric Board*, 81 FERC ¶ 61,270 (1997), *aff'd*, *American Rivers v. FERC*, 187 F.3d 1007 (9th Cir. 1999) (rejecting request for economic valuation of environmental resources that were the subject of 10(j) recommendations).

[49] Office of Energy Projects, Federal Energy Regulatory Commission, *Study Plan Determination for the Susitna-Watana Hydroelectric Project (Project No. 14241)*, February 1, 2013.

[50] Peter A. Diamond, and Jerry A. Hausman, *Contingent Valuation: Is Some Number Better Than No Number?*, Journal of Economic Perspectives, Volume 8, Number 4, Fall 1994, pp 45-64 at 45,46.

[51] National Research Council, Committee on Assessing and Valuing Aquatic and Related Terrestrial Ecosystems, *Valuing Ecosystem Services, Toward Better Environmental Decision-Making*, 2004, at 122.

[52] Kenneth Arrow et alia, *Report of the NOAA Panel on Contingent Valuation*, 1993, at 12, 13.

criteria, FERC explains that to estimate the level of effort and cost, a study proponent should, at a minimum, estimate the number of hours or person-days that would be required to conduct the requested study and identifiable tasks (e.g., report preparation). FERC states that the information gained under this criterion is also useful in weighing the costs and benefits of different methods for obtaining the needed information. While FERC may not reject a study based on cost alone, information on cost and level of effort is necessary for FERC to determine whether the requested information is in line with the magnitude of the potential effect of the Project on particular resources.

The proposed study does not meet this criterion. While FLOW states that data should be collected through surveys and interviews of known paddling clubs, customers of commercial whitewater outfitters, outfitters of tubing equipment and kayakers, canoeists, and rafters of varying abilities they fail to describe the level of effort or cost that such data collection would entail or the level of effort and cost that other elements of a contingent valuation study would entail.

In sum, FirstLight has not included FLOW's proposed study in its PSP because the proposed contingent valuation study will not inform the development of license requirements, is not accepted within the scientific community, and does not describe considerations of level of effort and cost.

4.5.2 Mitigation Impacts of the Connecticut River and Loss of Whitewater Recreation at and above Turners Falls Dam

New England Flow, American Whitewater, and The Appalachian Mountain Club (collectively referred to as FLOW) have requested that FirstLight conduct a study to assess regional whitewater boating resources in order to determine off-site mitigation.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

FLOW states that the goal of the study is to assess the presence, quality, access needs, flow information needs, and preferred flow regimes for regional whitewater boating resources that would mitigate for the loss of whitewater recreation at the Turners Falls Dam.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FLOW is not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

FLOW states that the Turners Falls dam removes the public's opportunity to enjoy a whitewater boating resource and that conducting studies and implementing necessary measures to ensure the public has access to whitewater recreational resources is in the public interest.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

FLOW states that current and historic project operations at the Turners Falls Dam do not provide meaningful information for determining off-site mitigation.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

FLOW states that the construction of the Turners Falls Dam dewatered the Turners Falls bypass reach and the creation of the Turners Falls Impoundment "drowned upstream rapids, which would be sufficient cause for off-site mitigation."

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

FLOW proposes the following "process" steps: desktop analyses of candidate rivers, resource agency identification and feasibility assessment, and inter-agency meetings with stakeholders to explore opportunities for mitigation.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

FLOW states that it is willing to work with FirstLight on an off-site mitigation study to keep costs reasonable and the quality of information high. FLOW has also proposed that FirstLight conduct a controlled-flow whitewater boating study.

FirstLight's Rationale for Not Adopting the Proposed Studies

FLOW's study proposal is in essence a request to explore off-site mitigation opportunities to compensate for alleged impacts caused by initial Project construction. FERC's analysis, however in a relicensing proceeding is based on existing conditions.[53] FERC's environmental review focuses on the fact that the Project already exists and is part of the existing environment.[54] In its *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria,* FERC reiterates that FERC uses current conditions as its baseline for evaluating project effects and alternatives and that this consists of the environment as it exists at the time of licensing.[55] The results of the proposed mitigation study would not inform the development of license requirements to address effects, if any, of Turners Falls Project operation on whitewater boating.

FirstLight agrees that a controlled-flow whitewater boating and paddling study may have a nexus to the current operation of the Turners Falls Project and has included this study proposal in the PSP (Study 3.6.3). FirstLight's proposed study will evaluate the effects of Turners Falls operation on the availability of whitewater and other recreational boating in the Turners Falls bypass reach. FirstLight, however, has not included the proposed mitigation study in the PSP because it is not a study designed to evaluate the effects of current Project operation on recreational boating.

Similarly, FLOW's proposed study does not describe a study methodology, but instead a process for identifying off-site mitigation measures. Finally, FLOW fails to explain why its proposed whitewater boating study will not suffice at evaluating the effects, if any, of Turners Falls Project operation on the availability of whitewater boating in the Turners Falls bypass reach.

In sum, FirstLight has not included the proposed request to assess regional whitewater boating resources in order to determine off-site mitigation in the PSP because (1) it is not a study request but a proposal to investigate potential PMEs, (2) it is based on an assumption of pre-project conditions and thus there is no nexus to Project operation, and (3) fails to describe methodology, and level of effort and cost.

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[53] *City of Tacoma,* 107 FERC ¶ 61,288, at 62,095 (June 21, 2004).
[54] *City of Tacoma,* 67 FERC ¶ 61,152, at 61,443-44 (1994).
[55] *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria,* at p. 14 (Federal Energy Regulatory Commission, Office of Energy Projects, March, 2012)

4.6 Cultural Resources

4.6.1 Assess Preservation of Cultural, Historical and Educational Resources

Appalachian Mountain Club, Vermont River Conservancy, and Friends of the Connecticut River Paddlers' Trail (collectively referred to as "AMC"), have requested a study regarding public education of the area's cultural resources and preservation of historical documents. The National Park Service and the Nolumbeka Project requested a similar study. Because the Nolumbeka Project's request does not meet FERC's study plan criteria, however, FirstLight has addressed the request in the comment matrix in Table 1.0-2. NPS's study request partially meets FERC's study plan criteria.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

AMC/NPS states that the goal of the study is to determine what actions should be taken to educate the public about an historical site that lies under the Turners Falls Impoundment, to determine what actions should (or should not) be taken to preserve artifacts, and to identify, preserve, and make available historical engineering drawings for the Projects to historians and researchers.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

AMC is not a resource agency. NPS is resource agency within the Department of Interior. NPS states that DOI has recognized the importance of the Connecticut River by designating at as the nation's first National Blueway on May 24, 2012..

Public Interest Considerations (18 CFR § 5.9(b)(3))

AMC/NPS states that historical records and education are valuable public resources.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

AMC/NPS states that there are many history books addressing the 1676 battle at Turners Falls and the King Phillip's War. AMC also cites two books regarding the engineering history of the Turners Falls site.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

AMC/NPS states that the Turners Falls Impoundment covers the site of the 1676 battle and probably artifacts. AMC/NPS also states that there may be Indian artifacts or burial grounds on the Turners Falls Project lands. AMC/NPS states that presumably FirstLight has in its possession historical records relating to the construction of the Turners Falls dam.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

AMC/NPS does not recommend a methodology other than to suggest that study methodology with respect to Native American use of the areas should be left to the Tribes, and to regional professional historians and others. AMC/NPS also notes the identity of a local organization with expertise in historical preservation and museum preservation.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

AMC/NPS does not describe level of effort and cost other than to state that there are academics and museum personnel who could do this study and make recommendations.

FirstLight's Rationale for Not Adopting the Proposed Studies

To the extent that AMC/NPS's request is to study or provide mitigation, protection, and enhancement for impacts resulting from original construction of the Turners Falls dam, as discussed previously in Section 4.5.2 of the PSP, such an approach would be inconsistent with FERC's environmental baseline, which looks at the impact of current Project operation and thus would not inform the development of conditions for a new license for the Turners Falls Project.

AMC/NPS's request is not a request for a study, but a request for PME. FirstLight is proposing to conduct a Phase 1A archaeological survey and a reconnaissance level historic structures survey for both the Turners Falls and Northfield Mountain Projects. See Studies 3.7.1 and 3.7.2. The results of those surveys will inform the need for more intensive cultural resources surveys. At the conclusion of cultural resources surveys, depending on survey results, FirstLight may prepare draft and final HPMPs, which will propose protection and mitigation measures for adverse effects, if any, to historic properties that are caused by the continued operation of the Project. It is premature to determine which measures, including education and preservation measures, should be included in the draft or final HPMP.

In sum, FirstLight has not included the proposed request for an assessment of cultural, historical and educational resources in the PSP because (1) it is not a study request but a proposal for PMEs, (2) to the extent it requests an assessment of pre-project conditions, there is no nexus to Project operation, and (3) fails to describe methodology, and level of effort and cost.

4.7 Other Project Relative Issues

4.7.1 Feasibility of Converting the Northfield Mountain Pumped Storage Project to a Closed-Loop or Partially Closed Loop System

The Town of Gill, LCCLC, FRCOG, FCD, and CRWC requested studies on the feasibility of converting the Northfield Mountain Pumped Storage Project into a closed-loop or partially closed-loop system.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

Proponents state that the objectives of the study would be to determine: (1) candidate locations for placement of a lower reservoir; (2) costs and logistics of construction and modification of the current facility to convert to a closed-loop or partially closed-loop system; (3) projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations that the facility will be required to implement in order to protect habitat and native fauna; and (4) other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

The Town of Gill, LCCLC, FRCOG, FCD, and CRWC are not resource agencies.

Public Interest Considerations (18 CFR § 5.9(b)(3))

Proponents state that it is in the public interest to ensure high quality habitat for migratory diadromous fish, and the Northfield Mountain project reduces the quality of habitat for these species through increased turbidity and deposition of fine-grained sediments and that the likelihood of entrainment and entrainment mortality.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents state that data on the environmental effects of the Northfield Mountain project and other facilities that use fresh or salt water for generation and/or cooling are widely available, citing data submitted in the PAD and the required conversion of a coal powered plant from open to closed cycle operation.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Proponents state that converting the Northfield Mountain project to a closed loop facility would eliminate environmental effects on fisheries, water quality, and erosion of farmland.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Proponents' methodology includes: (1) collate existing geological and hydrologic information of areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharges; (2) provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location; (3) provide information on whether and how a smaller lower reservoir would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River, the water quality effects, and decrease the possibility of entrainment; (4) provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month; (5) identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960s or any other time; (6) provide a cost estimate of each option considered and evaluated; and (7) provide an itemized cost estimate of how halting use of the Connecticut River as a lower reservoir would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at the projects, and fish protection measures.

Proponents state that the study methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

Proponents' state: "The level of effort to compile existing information and to make the data available in a map should be low, as should development of contingency scenarios. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work with some engineering and design work required to scope likely costs of various scenarios."

FirstLight's Rationale for Not Adopting the Proposed Studies

The proponents' suggestion that a useful study could be accomplished at low cost with "some engineering and design work" demonstrates a profound lack of understanding of the study costs involved in any major new or modified ground disturbing project. Any study of converting the Northfield Mountain facility to a closed-loop system with a new lower reservoir would essentially require a comprehensive analysis comparable to that required for development of a license application for a major new project or major license amendment. It would necessarily include a comprehensive review of existing geological and hydrologic information and new site-specific geologic investigations of any places where the new lower reservoir and associated project facilities (e.g., new forebay, tunnels, penstocks, and powerhouse), detailed engineering feasibility and costs analyses of potential lower reservoir alternative sites, project facilities, and reconfiguration of the upper reservoir to operate in connection with the new reservoir and facilities, and studies and analyses of environmental effects in any area where a new lower reservoir would be located. The site investigations from the 1960s would be next to, if not entirely, useless for these purposes.

Moreover, the Commission has recently stated that while the Federal Power Act authorizes it to require modifications to an applicant's proposal to ensure that the project is best adapted to a comprehensive plan for developing or improving a waterway, the Commission does not believe it has authority to require a license applicant to construct and operate an entirely different project from the one it has proposed. *See Erie Boulevard Hydropower, L.P.*, 120 FERC ¶ 61,267 at P 97 (2007). That would certainly be the case here.

4.7.2 Creation of a Decommissioning Fund

The NPS and, jointly, the AMC, Vermont Resources Conservancy (VRC), and Friends of the Connecticut River Paddlers Trails (FCRPT) (collectively, the study proponents) have requested studies related to decommissioning of the licensed projects. NPS seeks a study of the "financial production" of each project, which would be used in the Commission's public interest analysis to evaluate a requirement for the licensee to have a decommissioning fund for each project. AMC, VRC, and FCRPT seek a study to "determine the appropriate decommissioning costs at the end of the project's lifetime and how such costs should be funded . . . in advance."

Proponents' Descriptions of Study Goals and Objectives (18 CFR § 5.9(b)(1))

The study proponents state that the goal of their proposed studies is the establishment of a decommissioning fund, so that the public will not be burdened by the cost of decommissioning the projects.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

NPS is a federal resource agency. NPS states generally that its management goals with respect to the Connecticut River watershed are to promote a "water-based approach to conservation, outdoor recreation, education, and sustainable economic opportunities" and to "establish community-driven conservation and recreation for the 21st century."

Public Interest Considerations (18 CFR § 5.9(b)(3))

AMC, VRC, and FCRPT are not resource agencies. They state that the requested study is in the public interest because the project might one day be abandoned and the public might be required to bear the costs of remediating the site(s).

Proponents' Description of Existing Information and Need for Additional Information (18 CFR § 5.9(b)(4))

The study proponents allege that there are thousands of abandoned dams on New England waterways. They add that the physical and financial viability of the projects is at risk from various factors, such as extraordinary storms, foreign ownership, and international currency market fluctuations. NPS contends that decommissioning funds are commonly required for federally licensed facilities.

AMC, VRC, and FCRPT state that there appears to be no published information on the economic viability of the projects, which they believe is needed in order to establish their proposed decommissioning funds. NPS says essentially the same thing.

Proponents Description of Nexus Between Project Operation and Effects on Resources (18 CFR § 5.9(b)(5))

The study proponents state that there is a direct nexus between Project operations and the economic viability of the projects.

Proponents Explanation of How Methodology is Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

The study proponents state that the financial viability portion of the study would follow "normal procedures" in accounting and financial management.

Proponents' Description of Level of Effort and cost, and Why Alternative Studies are Insufficient to Meet the Stated Information Needs (18 CFR § 5.9(b)(7).

The proponents state that the study would be "relatively inexpensive" and that they are not aware of any means other than decommissioning funds to protect the public.

FirstLight's Rationale for Not Adopting the Proposed Studies

The proposed studies are not appropriate because the Commission has consistently denied requests for the establishment of decommissioning funds in new licenses. The Commission has found that such funds "unnecessarily tie[] up substantial amounts of the capital of financially sound licensees . . . . for extensive periods." Project Decommissioning at Relicensing; Policy Statement, FERC Stats. and Regs.¶ 31,011 at p. 31,234 (1995). Also, the Commission has not required a decommissioning fund where: (1) there is no evidence the project is economically or physically unsound; (2) no party has suggested decommissioning in the foreseeable future; (3) there is no evidence indicating that the physical life of the project will end during the term of the new license; or (4) there is no indication that the licensee would lack the financial resources to decommission the project if it were to be decommissioned. *See, e.g., Wis. Valley Improvement Co.*, 80 FERC ¶ 61,054 at p. 61,164 (1997); *N. States Power Co.-Wisconsin*, 78 FERC ¶ 61,120 at p. 61,460 (1997); *N. States Power Co.*, 78 FERC ¶ 61,363 at p. 62,511 (1997); *Wolverine Power Supply Coop., Inc.*, 85 FERC ¶ 61,030 at p. 61,090-91 (1998); *Potlatch Corp.*, 72 FERC ¶ 61,029 at p. 61,173 (1995). All these factors are present here. The Commission's policy has been found to be reasonable on judicial review. *See Kelley v. FERC*, 96 F.3d 1482, 1490 (D.C. Cir. 1996). Since there is no reason to impose the requested license condition, there is no reason to require the proposed studies.

In addition, the study requests are flawed because:

- The proponents' suggestion that extreme weather events put the licensed projects at risk has no support. The proponents have made no effort to explain how the existence of abandoned dam in New England, the vast majority of which are on small rivers or streams, and which were built as often as two hundred years ago using long since outdated construction methods, bear any relation to Commission-licensed projects, which are subject to perhaps the most rigorous dam safety requirements in the world.
- The useful physical and economic life of the projects cannot be determined. The Turners Falls project has been operating continuously for decades and there is no indication it cannot continue to be operated indefinitely. Similarly, all of the 17 pumped storage projects licensed by the Commission since 1958 and constructed are still operating and there is no reason to think any of them is approaching the end of its physical or economic life. Northfield Mountain is no different.
- The proponents' unsupported assertions notwithstanding, there are no "normal procedures" for estimating the potential cost of hypothetical decommissioning at an uncertain future time which could be far beyond the life of the next licenses, or even the next licenses after those. Any number of decommissioning scenarios that might be considered, and it is impossible to know with any certainty in advance which scenario would be adopted, let alone what engineering or environmental reviews would be appropriate, or the distant future legal and regulatory landscape.

Finally, NPS has made no effort to explain how the proposed study relates to its generally stated goals of promoting conservation and recreation. Rather, it merely cites the hypothetical future default which the Commission, with judicial approval, has stated is insufficient to require a decommissioning fund.